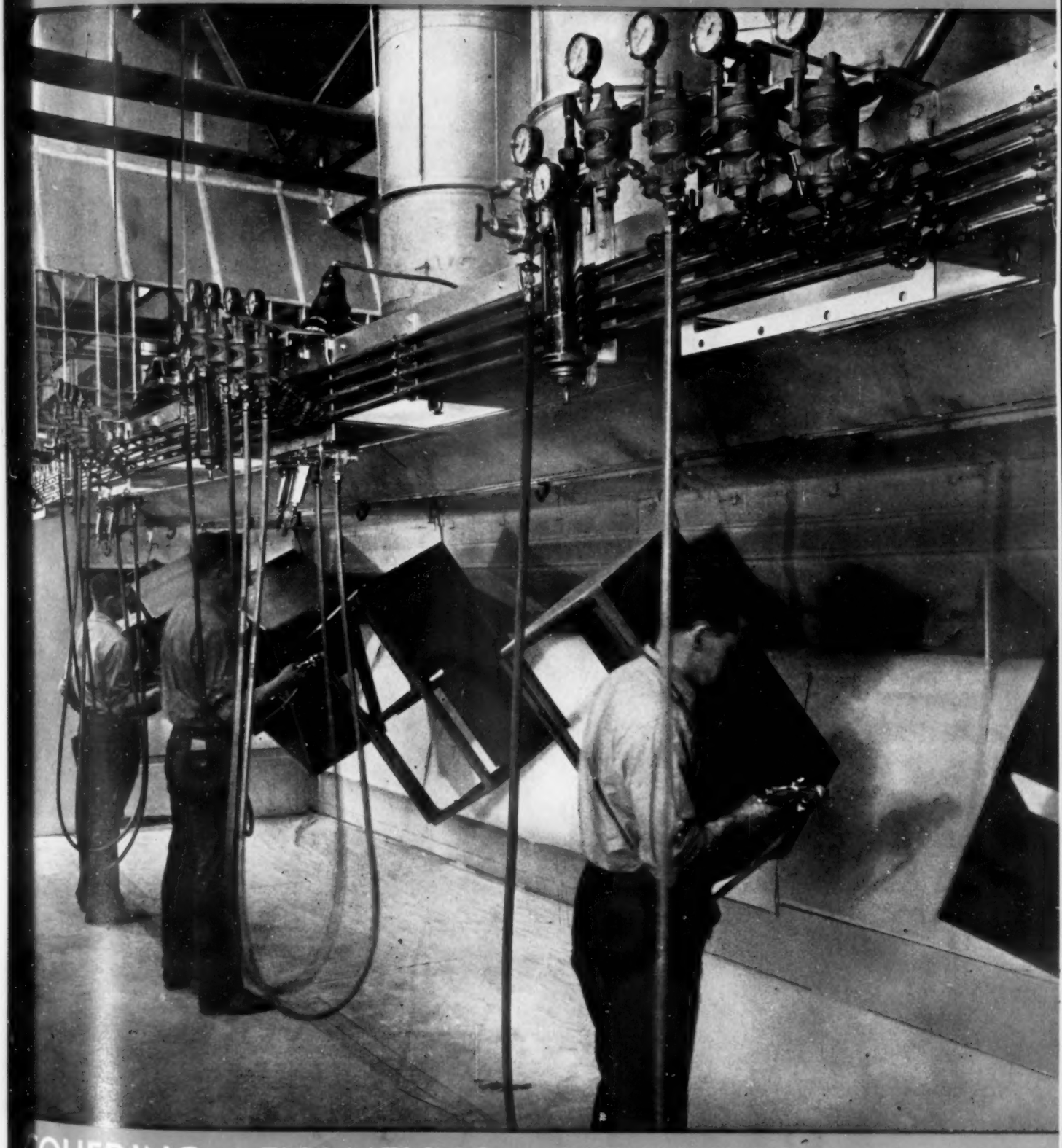
MAY, 1941

# ORGANIC FINISHING

## SECTION OF METAL FINISHING



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## Proper Use Of Aluminum Pigments

Manufacturers of organic finishing materials and producers of aluminum pigments have always stressed the importance of using the correct proportions of vehicle and aluminum paste or powder when making up aluminum paints, lacquers, etc. There should be no guesswork in the amounts. The vehicle should be carefully measured by volume and the requisite amount of aluminum pigment as carefully weighed out before the two are mixed. This is only common sense if good and uniform results are to be expected.

In these days of national defense preparation, the question of mixing aluminum finishing material assumes a new importance. There are two reasons. First, there is the point of quality of aluminum finishes, particularly in applications on articles which are slated for use, either directly or indirectly, in the defense of our nation. The useful life of a large variety of equipment, machinery, etc. depends on its finish for protection against moisture, chemical corrosion and the like. It is conceivable that a poorly prepared finishing material might result in the failure of a particularly important piece of equipment at a time when it is badly needed. At the very least, such a failure would necessitate a replacement and the time, materials and machinery necessary to produce that replacement might well have been used for something more constructive.

The second reason has to do with the availability of aluminum pastes and powders. Aluminum, as is well known, is a strategic defense material. If, by guessing at the amount of aluminum pigment to be used in making up an aluminum finishing material, more than is necessary is used, it means that some of this important material has been wasted. It has been wasted just as surely as if it had been thrown away and such losses simply cannot be made.

The point of proper use of aluminum pigments as it affects defense may appear to be of small importance to some people. Some may say that it is only a very minor detail. However, any plan, including our defense program, is only as successful as it is complete in detail and we feel justified in bringing this detail to the attention of our readers.

L. H. LANGDON, *Publisher* • T. A. TRUMBOUR, *Business Manager* • DR. WALTER R. MEYER, *Editor*

# Modern Paint Mixing Room in Auto Plant

By WILLIAM OGILVY

*Paint Mixing Foreman*

*Packard Motor Car Co., Detroit*

A glimpse into the finishing department of an automobile plant may reveal surprises even to the initiated. The preparatory cleaning, the type of coatings to be used, the number of these to be applied, the method and equipment of applying them, and even the handling of the paint itself and conveying it to the operator, have all been the subject of much thought and research, so that cars may be able to withstand all kinds of weather and atmospheric conditions.

Take, for instance, the Packard Motor Car Company, in Detroit, whose new paint mixing room is said by paint experts to have no equal for compactness of layout, simplicity in handling and mixing of paints, and efficiency of equipment. The system has now been in continuous operation for a little more than a year without a break or stoppage in the steady production of Packard cars.

In the paint room there are eighteen huge 175-gal tanks mounted on a long platform. Two of these tanks are used for mixing the primer and surfacer; two for the black inspection lacquer; two are for reclaimed lacquer; one serves as an auxiliary; and eleven are for the various colored lacquers.

Colored lacquer is received at the plant in 50-gal. drums, which are handled by an overhead hoist, and when in proper position, they are tilted slightly so that the contents flow steadily into a nozzle made of brass to avoid static electricity, and through a pipe which in turn discharges into the designated 175-gal. mixing tank situated on the platform. As the lacquer flows into the mixing tank, an equal portion of a solvent is also poured into the tank.

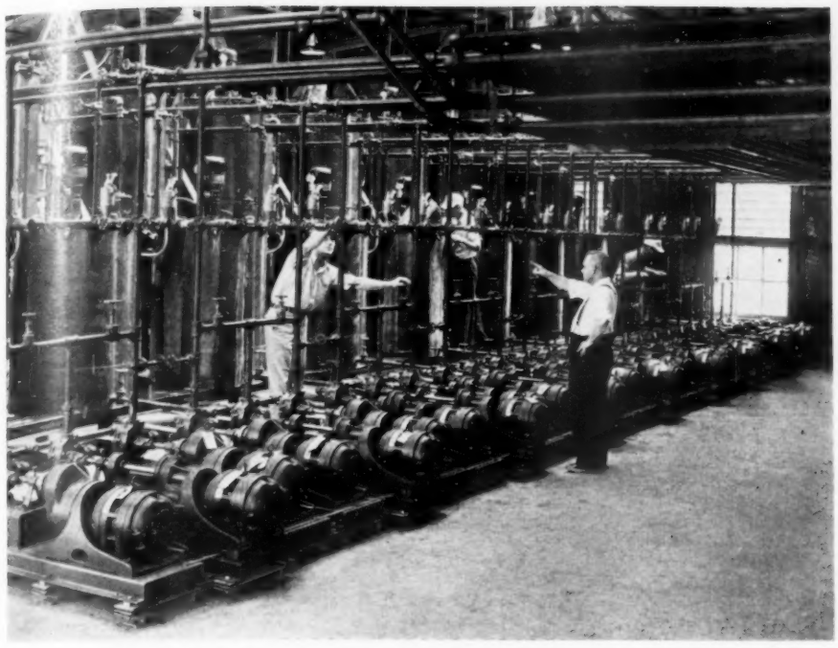
Each mixing tank is equipped with an agitator, powered by an explosion-proof motor mounted on top of the tank, so that the contents may be kept constantly in motion, preventing the settling of the pigments.

**A 1941 Packard one-sixty touring sedan finished in two colors.**

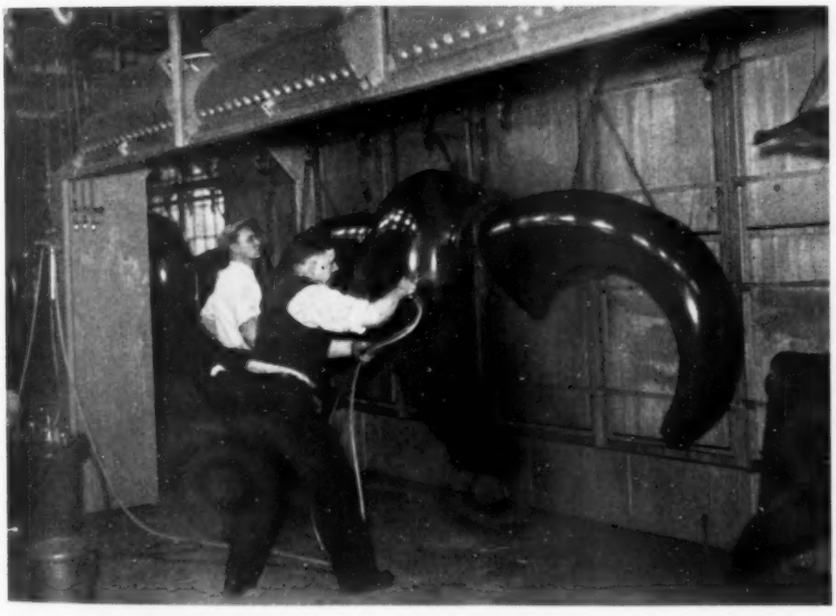
From the mixing tanks, the paint passes into reservoir tanks of 175-gal. capacity. These are on the floor, each being directly in front of its mate. Each pair of mixing tank and reservoir is connected by the necessary piping. The reservoirs are also equipped with motor-driven agitators which operate continually so that the paint will not settle.

The row of eighteen reservoir tanks is served by a battery of rotary pumps, each direct-connected through a gear reducer to a 2-hp. explosion-proof motor. There are three pumps to serve each reservoir,—one to pump paint through the line to the spray booths in the hardware division where the fenders and bonnet are finished, and another to pump paint through the line leading to the body division. Between each pair of pumps is a spare pump capable of generating sufficient pressure to care for both lines served by a reservoir should anything happen to either one or both of the other pumps. These spare pumps are also used for keeping the paint circulating during those periods when the plant is not in operation. In this way a spare pump

**Spraying finishing coats from both sides as an auto body passes along for final finishing.**



Partial view of paint mixing room showing battery of motor-driven rotary pumps with reservoirs and mixing tanks in rear.



Fenders passing through spray booth in hardware division.

will work sixteen hours, while the operating pair may only work eight. The reason for this change-over is to ward off any excessive wear on the operating pumps, which would occur if they were run continuously.

Pumped under sixty pounds pressure, the paint is kept in constant movement through two circulating paint lines on each reservoir drum—one leading to the spray booths in the hardware division and the other to the body shop spray booths. These lines are each 1800 ft. long with a return line of the same length leading back to the respective reservoir tanks in the paint room. The outgoing and incoming lines of each of the eighteen reservoirs form continuous circuits, the paint being kept in constant circulation between the spray booths and the reservoirs.

The pipes carrying the paint to the spray booths are $1\frac{1}{4}$" in diameter, while the return lines are of 1 in. diameter. There is a total of some twenty in the hardware division—booths—twenty in the body shop and thirteen miles of piping, each circuit holding approximately 500 gal. of paint.

All told there are forty spray each booth having lines connecting with the reservoirs containing the eleven basic colors in the paint room. There are five special colors that are also used, being sprayed from tanks in the booths, since these are not used in sufficient quantity to warrant piping from the paint mixing room.

The body of the cars, after a complete cleaning process, receives two coats of prime or surfacer, which provides a heavy protective film of rust-resistant paint. Then it is placed in an oven for an hour and fifteen minutes at a temperature of 200° F. After that, a tuscan red inspection coat is applied to bring out and emphasize any imperfections and to provide an opportunity for correcting them before the application of further finishing coats,—lacquer. The body then starts on its journey through the long row of spray booths, the body being suspended from an overhead conveyor line, and receives coat after coat of colored lacquer. There is an interval of about one minute between coats, allowing the paint to dry a little. One man sprays the top, another one side, and still another man sprays the other side. The body continues to move, and at successive booths it is sprayed by another set of men. Five coats of the solid colors are thus applied and six of the metallic. After its final coat it goes into an oven (set at 180° F.) and remains there for forty minutes. Fenders and other lacquered parts are treated similarly as they pass through the spray booths in the hardware division.

In the paint mixing room and in each spray booth are fire boxes in each of which is a thin glass door. The mere smashing of the glass on any of these boxes will at once break the electric circuit, shutting off the power to the pumps, and instantly stopping the flow of paint through the circulating pipe lines. As a further precaution, every object in the paint mixing room is grounded, to prevent static electricity.

# Automatic Spray Coating and Finishing Machines

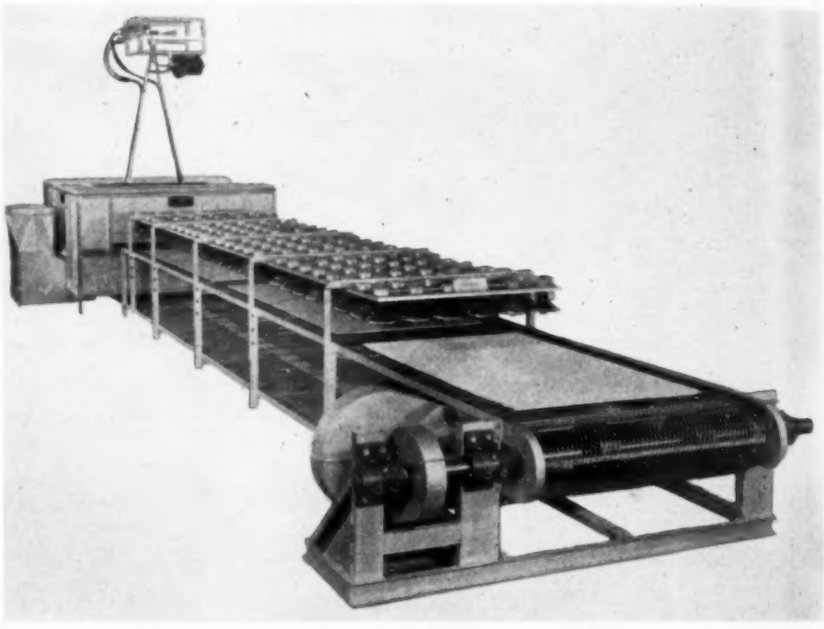
At least 85% of all the products of industry requiring a surface finish are given that finish by means of the spray gun. The spray process is so generally accepted as the only means of coating and finishing that there seems no longer to be any comparison between the spray and older methods.

Even though the spray has so completely outmoded older finishing methods in speed and quality of work produced, industry is today no more satisfied with its finishing speed than it is with the speed of its other production operations. The cry today is faster—faster and the producers of spray finishing and spray painting equipment are answering that cry by the development of machines and equipment that are as far beyond the capacity of the hand operated spray gun as the spray gun was beyond the brush.

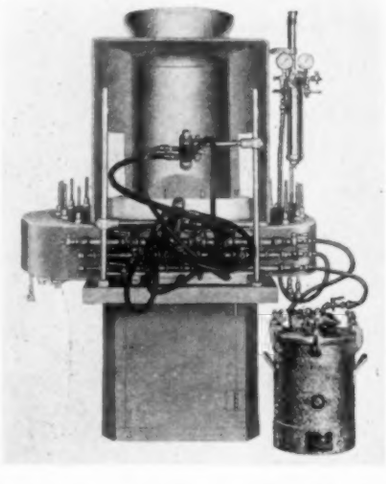
### *Rotary Finishing Machine*

Production finishing can now be done by machines in automatic operation very much the same as in other manufacturing processes. The rotary spray finishing machines, for instance, will do as many as 3,600 small, light weight articles an hour. The product to be coated or finished is loaded on one end of the machine and comes out finished at the other end. Such a machine can be set into the production line, receive the article mechanically from the last manufacturing operation and discharge it completely finished and dry to a wrapping or packaging machine.

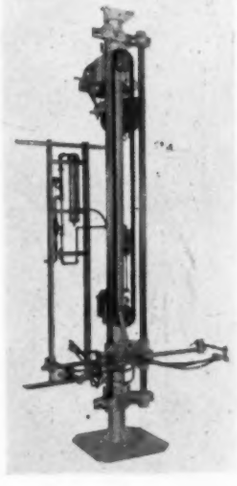
The basic principle of the rotary machine is the rotation of the product to be finished before an open spray gun. Machine design and operation vary with product and plant requirements. Usually, however, the product is loaded on a workholder or spindle which starts rotating just before it enters the spray gun range and stops rotating as soon as it passes the gun. This assures even coating of the object. One or more spray guns are so



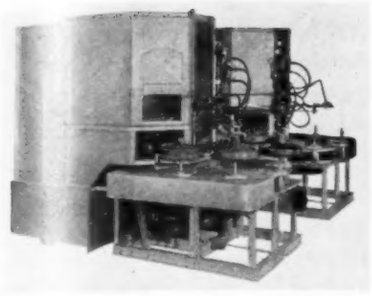
Sheet insulating material is automatically coated with this swinging arm machine which includes conveyor and spray booth. Equipped with infra-red ray drying station ahead of the spraying operation.



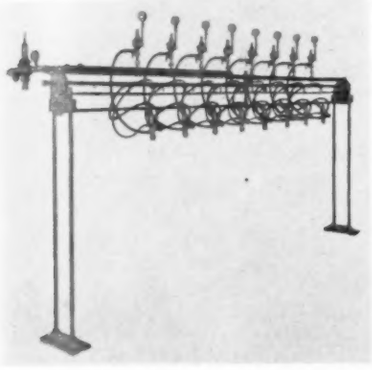
A medium size rotary automatic spray finishing machine for finishing golf balls, bottles, jars, toys and other small products. Production speed up to 3,000 pieces an hour.



A vertical transverse automatic coating machine designed to coat flat articles suspended from overhead conveyor. Guns move up and down and can be set at such angles to spray sides, tops and edges.



This is a heavy duty rotary type finishing machine built to automatically paint automobile wheels.



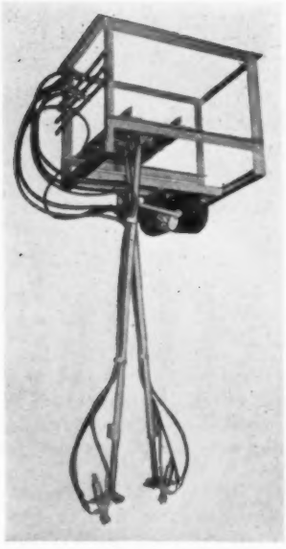
This is a gang spray, the simplest form of automatic spray coating machine. Designed for high speed where fine finish is not of first importance. Mounted over conveyor with guns in continuous operation or may be equipped for automatic start and stop.

mounted that the spray is properly directed to reach all exposed surfaces. Gun operation may be continuous or operating devices such as the electric eye or mechanical cam start and stop the spray at the proper instant as the object rotates before the spray gun.

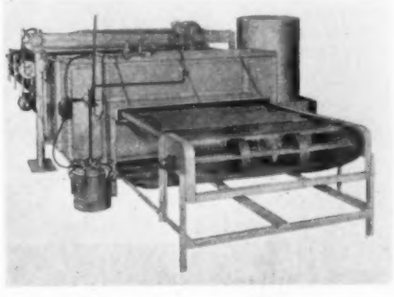
### *Horizontal Transverse Machines*

Larger products in sheet, roll or panel form with curved or flat surfaces are automatically and mechanically sprayed at a rate of 240 square feet per minute by machines of another type. These are frequently referred to as swinging arm, horizontal transverse and vertical transverse spray coating machines. Each has its particular application according to the requirements of product or production.

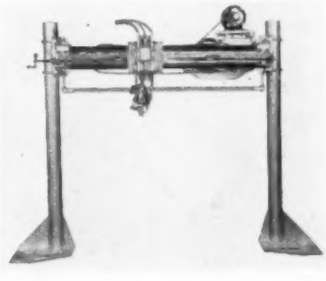
The swinging arm machine automatically sprays flat articles and products such as wall board, wall coverings, paper, fabrics, etc., which do not exceed four feet in width. The guns, mounted on long arms, swing back and forth across the work very much the same as the human arm in manual spraying.



A swinging arm spray coating machine. Two swinging arms each with gun, gear operated. Guns automatically open and close at start and finish of each stroke.



A complete transverse machine including spray booth and conveyor.



The spray mechanism of a horizontal transverse spray machine for coating large flat surfaces. Equipment is placed over a conveyor and inside a spray booth. Guns move back and forth across the work.

Another machine for automatically spraying flat objects as they are conveyed in a horizontal position is called the horizontal transverse spray coating machine. Designed for operation over a conveyor, the work passes under the guns as they move back and forth across the work. This machine is usually employed for coating larger objects such as metal sheets, paper, leather, wall board, composition material, etc. It can be detailed to fit product, conveyor speed, coating material or other condition which must be reckoned with in automatic spray operation.

### *Vertical Transverse Machines*

Some times the transverse machine is mounted vertically instead of horizontally—and such a machine can really do tricks. This machine is usually used to coat both sides of panels or forms as they move before the guns suspended from an overhead conveyor. The guns move up and down and can be mounted to spray one or two sides of the product, edges, around corners and other difficult spots which all must be caught in one spraying operation.

### *Applications Unlimited*

While these are basic designs of automatic spray coating and finishing machines, each can be adapted to a multiple of special operations and special machines of unusual nature are being built to handle peculiar finishing operations which can be accomplished automatically if justified by the speed desired and volume of production. Hardly a day passes but some manufacturer installs a machine specially designed and built to meet the particular requirements of his finishing operation to speed up his production and lower his costs.

One manufacturer finishes 3,000 camera parts an hour, another does 1,200 lamp shades. Pipe is painted at a rate of 200 feet a minute, shingles coated two a second. Nine hundred clock cases finished in an hour on a rotary machine, 10,000 doll heads in an eight hour day Another machine does 120 finely finished pieces of table ware, lipstick cases are coated at a speed of 3,000 per hour and automobile wheels at 1,200 an hour. Automatic machines spray paint on axle assemblies, glue on veneers, dyes on leather, porcelain enamel on metal panels, graphite on gaskets, paraffine on cartons, lacquer on golf balls. Wherever there is a volume coating or finishing operation to be done it can be accomplished with speed, economy and quality of finish by automatic machine just as satisfactorily as machine operation in other production processes.

Editor's note: Information and illustrations in this article were furnished thru the kindness of The De Vilbiss Co., Toledo, Ohio.

# Overcoming Metal Lacquering Problems

By FRANK V. FAULHABER

*Brooklyn, N. Y.*

**The author explicitly explains how to solve a wealth of metal lacquering troubles, with special reference to spraying difficulties. Purchasing the right lacquers, maintaining proper finishing conditions, lacquer tests. Die castings and fine, delicate finishes are discussed. Proficient finishing sees that the product, such as high-grade silver-plated dials, reaches the consignee in perfect, unmarred condition.—Ed.**

It is often a question in metal finishing plants what kind of lacquering equipment to use. This depends in large part upon the character and quantity of work put out. Aside from the various spraying and dipping methods, considerable lacquering is done by roller coating and tumbling processes. There are other types of lacquering systems, but the vast majority of lacquering is done by spray gun. Essentially, no matter what manner of equipment is employed, it should be the best of its kind, be maintained in the most efficient operating condition, and always be used correctly.

Most of the spray guns manufactured are for low or moderate air pressure. Experienced finishers claim a greater covering capacity for the low or moderate air pressure guns. Such pressure guns assure better flow, there is less removal of volatiles, fewer fumes, and less mist, overspray or drift. By and large, such spray guns in the long run are considerably cheaper. There is a wide variance in price for spray guns and the management's selections should not be governed by the cost. Under practically all working conditions the spray operator should have a gun giving complete control of air and liquid, so that both can easily be regulated.

### *Vital Spray Points*

In the aim for exemplary lacquering, the spray gun, under correct use, should give a uniform application; no splitting, no dry spots, no dark center, and as little mist or overspray as possible. It is important that the spray gun parts be readily interchangeable, so the spray guns can be obtained on short notice and be stocked inexpensively. The nozzles should be easily and accurately adjustable. The spray gun should not be of the kind that clogs too easily, should be durable—and stand hardy service; and yet be simple as possible, mechanically. If it is too intricate, it may not clean easily and thus may tend to put a damper on this routine. The spray gun, preferably, should be constructed with a minimum of parts contacting the liquid, and these parts should be accessible.

Although it is desirable that the finishing operator understands his spray gun thoroughly, and to possess knowledge as to its correct use if satisfactory results are to be obtained, the workman's curiosity should not impel him to toy or experiment unnecessarily with the gun. Not more of the spray gun should be dismantled than necessary. Taking the gun apart, "to see how it works," may ever after prevent the operator from getting the results that the spray gun manufacturer intended he should.

Spray guns in steady service should be taken apart completely and be thoroughly cleaned and inspected twice a week, and this only by one fully versed in the work. In very large

A final high lustre lacquer coating is desirable for automatic candy dispensing machines.

plant one individual is assigned to the cleaning and inspecting of all spray guns, and in accordance with manufacturers' instructions. Informational charts are procurable that give the spray gun operator all important details and enable him to take better care of the guns and achieve the best results through their use.

The finisher thus becomes familiar with the mechanism and the function of the various parts of his spray gun. Thus he also becomes more proficient in replacing parts whenever necessary without unduly retarding his other work.

### *Avoid Mishandling*

Plant foremen desirous of better lacquering with hand spray guns may well give special consideration to new operators who perhaps may be uninitiated regarding the finer points They should be duly cautioned and enlightened. Some operators, mayhap unknowingly, will ram a piece of wire into the air outlets of spray guns. A gun may be of such a type, and of that kind of metal, that will not withstand such mishandling. A spray gun can be abused and broken down too readily, albeit unintentionally, and though the operator may mean well. Many spray guns have forever been put out of use completely just because of incorrect cleaning procedure.

One harried finishing foreman encountered an extended run of lacquering troubles and his department experimented with a varied assortment of spray guns before he finally came upon the true source of fault. Concentrating, finally, more upon inspection, it came to light that there was too much improper, clumsy cleaning and that the guns themselves were not defective or inefficient. Carefree boys or others unauthorized to use the guns should be restrained from meddling with this equipment if better lacquering is to prevail.

Other spray gun troubles that sometimes bother are such as split or hollow spray, lop-sided or one-sided spray, fluttering or jerky spray, excessive mist, excessive flowage, fluid leakage, inefficient atomization—any of which may conduce towards second-rate results. There is a reason accounting for each one of them.

The lacquer distributing streakily brings about split spray; there will be heavy coating on the outer edges of the fan spray, with very little material depositing in the center. This defection may be accountable either to wrong adjustment of the spreader adjustment valve, or to excessive air pressure causing blowage of material from center of spray.

Lop-sided or one-sided spray is brought on whenever the lacquer gravitates inordinately heavy on one side of the fan-shaped spray, causing a very uneven coating. This finishing defect is due to cloggage of the air port on the air cap. Frequently a bent air port or bent edge on the fluid tip may bring about the trouble. When the air port does clog, the operator must never resort to wire probing or cleaning. Instead, the air cap should be placed in a solvent appropriate for the material in use, thence blowing it out with air.

### *A Delicate Instrument*

A spray gun, notwithstanding all the fine work it can accomplish, is a delicate instrument. For that reason, moreover, it is meet that the operator handles a spray gun carefully. Dropping of a gun onto a floor, and such, and a host of other reasons, may be the cause of the air port being turned to one side or bent. A new air cap is then in order, as ordinarily it is next to impossible or inadvisable to straighten the bent air port, or expect to restore the impaired air port to efficient use.

Occasionally, through long overuse, the steady wear of the fluid needle on the fluid point may cause it to become thin and split. Usually, then, new parts represent the most advisable procedure. There have been instances where, because of ignorance or economy, the management required the spray gun operator to fret along with faulty parts, resulting altogether in decidedly inferior work. Ignorance in such cases is often costly, and it is problematical just where the question of economy enters.

It is impossible to coat or spray lacquer at all when the finisher is faced with fluttering or jerky spray. The material issues from the tool in jerks, causing patchy spraying or coating of the product. Various reasons account. The fluid tip may be loose, or cloggage of the gun, the latter sometimes by a bit of dirt or foreign substance. The air may be leaking into the fluid line, or there may be a worn-out fluid-tip gasket.

It is forehanded procedure, incidentally, to strain lacquers to be sprayed, if the plant is striving for cleaner finishes, and this is all the more desirable in the case of fine, delicate finishes, such as highly plated work, silver watch dials, gauges, etc., where the bright finishes also sometimes have a tendency to discolor. As careful and efficient as lacquer manufacturers are nowadays, lacquer materials even from the same lot may sometimes vary enough to bother the finisher executing, for instance, superior silver and plated work. In each case, of course, the lacquer in use should be specifically intended for the work on order.

Another spray difficulty relates to an overplus of mist over the product. This sometimes results through increased flow of finish or excessive air pressure. When the material uncontrollingly drops onto the work, the trouble is due to leakage at point of fluid tip. Under such circumstances, superlative work is absolutely out of the question. A worn-out fluid needle or needle improperly regulated may be the cause. Stressingly so when lacquer is sprayed, it is expedient to have ready a number of needles, for under such use the wear is more severe. It is the part of foresight, incidentally, to be adequately supplied with replacement parts to permit quick repairage of gun, so as not to hinder or disrupt the plant output. More often than finishing operators would wish, one or another part of the gun will become deficient or break.

### *Faulty Lacquering*

Other faulty lacquering by spray gun is the pebbly or orange peel effect in the film. This is occasioned by the fact the lacquer dried after leaving the spray gun nozzle before reaching the surface of the product. The result is that the issuing lacquer strikes as a dust instead of a liquid. In such case, the gun usually operates at too high a pressure and the finisher is working too far from the product being lacquered.

Fast drying lacquers should be sprayed with an air cap that develops a pattern with a heavy center so that the material will still be wet when it comes in contact with the surface. This is essential, since lacquers are practically dry immediately after spraying and, when under excessive air pressure, may be almost dry even be-

fore the material is deposited on the finishing surface.

A vital point is that synthetic materials are slower drying than lacquer. Air caps for spraying synthetics issue a greater volume of air than those commonly used when spraying lacquers, and the fluid tip for synthetics is smaller than the one intended for lacquers. An important requirement, hence, is to use the proper spray head for each type of material. The spray heads, however, are readily interchangeable in the spray gun assembly.

Sometimes the dusty or pebbly effect of lacquer spray may be due to the improper thinner. The solvent content must be balanced correctly; to illustrate, butyl or an amyl acetate type solvents have less tendency to cause dusting than methyl or ethyl acetate type solvents.

Another lacquer spraying defect is the sagging or running appearance of the coated material. Usually this is the result of too heavy a coat of lacquer, too much material issues, there is lack of uniform control, resulting in overcoating and uneven spraying. The operator may be spraying too close to the finishing surface, and if he moves his gun too slowly or permits it to remain overlong at any point, the lacquer naturally has a tendency to pile up. Ordinarily lacquer accounts for fewer sagging or running defects than other types of finishes by reason of its rapid drying qualities. Nevertheless, when lacquer piles up faster than its solvents vaporize, this finishing defect follows. The fault may partly be overcome by putting more thinner into the lacquer, to reduce its viscosity. When the thinner has the correct solvent content so that the lacquer will not be too heavily-bodied, other essential conditions prevailing, the atomization will be more nearly perfect and there will be better flowage of the material.

### *Spray Technique*

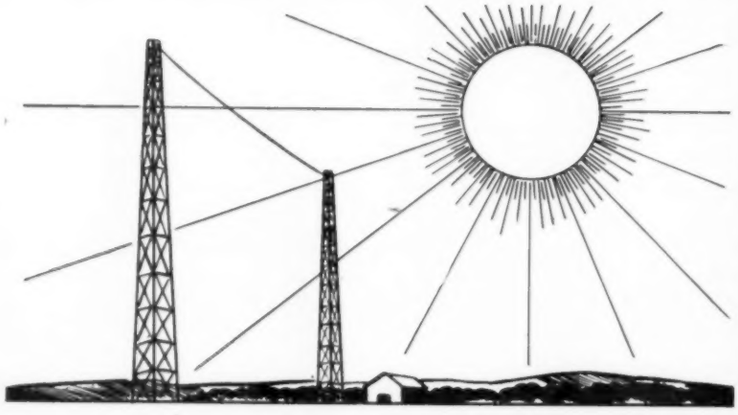
It is often asked at what air pressure the finishing operator should use his spray gun and at what distance he should apply the lacquer. There are many governing factors. Aside from the question of the finishing material being sprayed, the type of gun being used, and the character of the product being finished have bearing. It is also noteworthy that some spray operators achieve satisfactory results at their own preferred air pressures and by the peculiar technique they employ. It cannot lightly be gainsaid that it depends appreciably upon the individual operator as to the methods used and the results achieved.

Some spray guns are not suitable for fine atomization at any pressure, whereas others will spray effectively at pressures as low as 20 pounds. Although some finishing foremen prefer excessive air pressure spraying, to expedite operations, others disfavor such high pressure finishing because of the undue wastage of material.

An initial procedure is to start with a pressure of between 50 and 60 pounds. Spray a pattern on some flat surface to obtain an illustration of the atomization produced at that pressure. When this demonstration shows large dots in the overspray, it indicates an insufficient atomization and calls for increased air pressure. When the atomization as tested is excessive, reduce the pressure until the smallest possible dots in the overspray emanate.

### *Atomization Test*

When an atomization test is being made, regulate the spray gun for proper flowage and spray width. These two adjustments are made at the back of the gun. The fluid flow can be increased by turning the fluid adjusting screw to the left, and decreased by turning this screw to the right. The dialed spreader adjustment valve just above the fluid adjusting screw permits the operator to control the width

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of the spray. By turning this valve to the right the width of the spray is decreased by turning it to the left it is increased. Variation of spray pattern from round to extremely wide is brought about through the use of this valve.

So that desired spray patterns can be recorded and returned to at will, the face of this valve is graduated and marked. When this valve is set for a spray that is too wide for the finishing material, a split spray will result. This is a spray pattern with a thin center and heavy ends. Whenever this develops, reduce the spray width until the spray pattern is of uniform density. It is desirable that the start be made with this spreader adjustment valve setting at between 4 and 6. The setting producing the most efficient spray can be attained from this point.

A major aim of the modern finishing plant is for speed, but it is well to bear in mind there are certain limitations to make for efficient spray lacquering. The spray operator should use a stroke only as wide as can be applied conveniently and effectively.

*(To be continued)*


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**S-310** is a clear, pale liquid which can be reduced 150-200%. This solution can be applied to bright metal surfaces by dip or spray and gives a remarkably hard, tough and adhesive film of pronounced resistance to rust or tarnish.

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We welcome inquiries as to its applicability to your specific problem.

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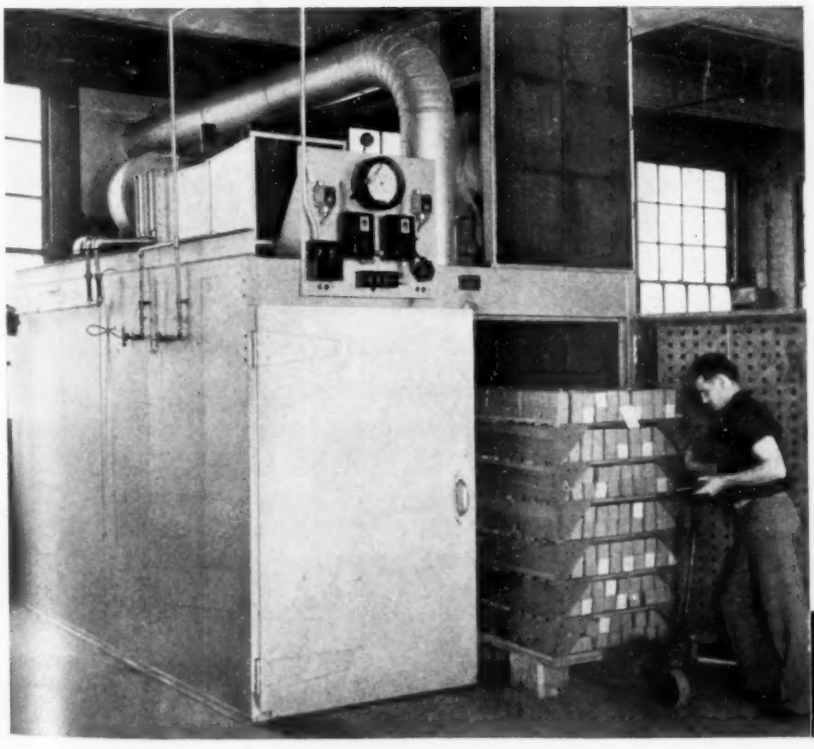

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## Shop Problems

### *Color Matching*

*Question.* In the manufacture of small specialties we are occasionally requested to match certain colors. The quantities are relatively small and we hesitate to order the necessary finishing materials both because of the cost and because of the time required. We have considered doing our own color matching and as a matter of fact, have already attempted this but without much success. Can you give us any information on color matching, particularly what standard colors we should use and what general procedure should be followed.

*Answer.* Matching the color of organic finishing material is an art and requires considerable experience. However, with the proper base colors and with some practice it can be done successfully.

To answer your specific questions, it is suggested that you purchase a complete variety of base colors from one of the manufacturers of finishing materials who specialize in supplying such materials. Having these colors, it will then be possible to obtain almost any color.

With regard to the procedure followed in color matching, the supplier of base colors can give information in general on what colors are used to produce other colors. Obtaining the exact shade then becomes a matter of trial using various proportions of materials. There are, however, certain rules which must be kept in mind. For example, the base colors must be thoroughly stirred before the matching is begun. Each mixture must also be thoroughly stirred before the matching is begun. For best results use natural light. Clean mixing containers must be used since small traces of other colors will throw off the color. Wait until the test panel is thoroughly dry before comparison with the color to be matched. Additions of color must be made in small amounts since, if large quantities are added, the proper color may be exceeded.

### *Room Paint*

*Question.* We are considering repainting a room in which rather small finished parts are assembled. Can you recommend a type of paint for this room which might be used to give a maximum of light and require a minimum of maintenance?

*Answer.* Tests have shown that white or lightly tinted paints on walls and ceilings are superior to dark paints where good illumination is concerned. Many white paints have light reflection values approaching eighty-five per cent efficiency. Light colors such as cream, ivory and light yellow range from sixty to seventy per cent. Red, blue, green and other dark colors go down to ten per cent and lower.

There may be some objection to the use of white paint in that it may become dirty under certain conditions and require repainting. However, most white paint formulated for interior application can be cleaned at low cost by simple washing, thus restoring its light efficiency to almost its original value.

### *Dull Spots On Gloss Enamel*

*Question.* We are using a high gloss black baking enamel and occasionally are troubled with having portions of the parts come from the oven with areas of low gloss.

*Answer.* There are a number of reasons for flat spots on baked finishes. It may be due to improper ventilation of ovens or to uneven temperatures which cause overbaking of parts of the work. If the work is not entirely clean of grease, oil, dirt, etc., flat spots may appear. Finally, certain metals occasionally possess surface characteristics which produce areas of low gloss.

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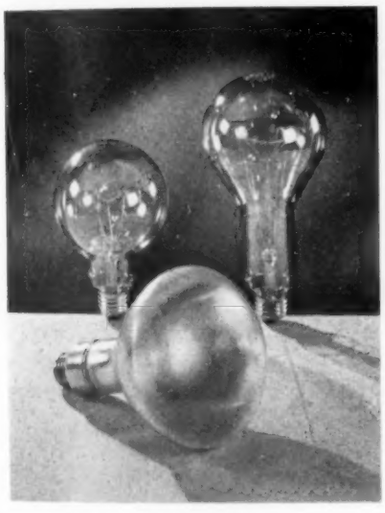
# NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

## Infra-Red Heat Lamps

Three new infra-red heat lamps will be placed on the market May 15th, by the Birdseye Division of Wabash Appliance Corporation, Brooklyn, N. Y. Two of the lamps will be clear, for use with the standard gold-plated or Alzac reflectors, but the third will not require any separate reflector since it will be built with its own reflector lining sealed inside to keep it free from oxidation and the collection of dust, dirt and fumes. The manufacturer states that the reflector lining will keep heat-reflecting value for the 6,000 hour life of the bulb because it will be made of pure solid silver which will be sealed inside the gas-filled bulb.



Infra-red heat lamps.

Differing from incandescent lamps used for lighting, the filaments of the Birdseye infra-red lamps operate at lower temperatures, developing infra-red radiant energy at wave lengths which have high penetration. The unique property of these lamps and of infra-red radiant energy developed is their ability to penetrate deep down into the surface films of lacquers, paints and enamels to start the baking and drying process from the inside out, instantly, and uniformly.

Complete information on Birdseye heat lamps and on the subject of baking, drying and dehydrating with infra-red radiant energy is contained in bulletin No. 121B just issued by the Wabash Appliance Corporation, Brooklyn, N. Y.

## Marking Enameled Metals

A new method of marking enameled metals without engraving has been discovered by the Acromark Corporation, Elizabeth, New Jersey. This new method is said to reduce the marking time by at least ten to one and gives more attractive results.

Successful results were obtained with Roxalin metal coatings also made in Elizabeth. The process consists of a steel die application to the coated metal under electrically controlled conditions and the mark of metal or color pigment results.

Binocular parts, enameled tubes, camera parts, instrument cases and a wide variety of enameled metal products can be trademarked, numbered or otherwise marked by this new process and a special machine to simplify the marking procedure has also been developed by Acromark.

First applications of the new process were on army binoculars and cameras for the British Government. It is thought that the method should reduce, very greatly, the cost and production time of numerous instruments and articles vital to defense.

## Oilless Paint Sprayer

W. R. Brown Corp., have announced the development of a new paint sprayer, their "No. 890 Speedy Sprayer," which is reported to be a practical all-purpose heavy duty spraying outfit. It is built on a special diaphragm principle, and is said to deliver clean oil-free air because it has no oily rings, pistons or cylinders to come in contact with the air or paint.

It contains factory-sealed, pre-lubricated bearings and thus is reported to never require oiling. It is recommended for spraying, both inside and outside, paints, lacquers, enamels, varnishes, etc.

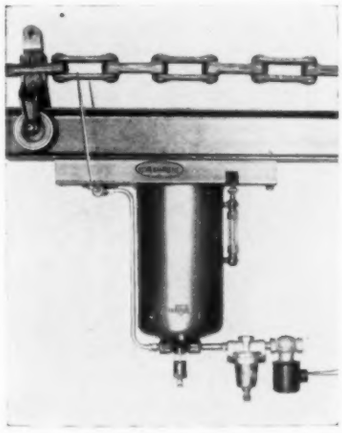
The outfit supplies compressed air for any purpose, and can be used for a vacuum pump. It is portable and compact.

For further information about this sprayer, write to W. R. Brown Corp., 5720 Armitage Ave., Dept. M.F., Chicago, Ill.

## Oven Chain Lubricator

To solve the problem of lubricating the chain links of conveyors passing through ovens, kilns and other hot zones, J. N. Fauver Co., Inc., 49 West Hancock Avenue, Detroit, Mich., offer an automatic conveyor chain lubricator. In a typical case, the chain of a 250-ft. conveyor, designed to travel at the rate of two feet per min., through a firing kiln, frequently "froze" when passing over driving and idling sprockets, resulting in changing speed of chain travel and uneven firing of the ceramic products passing through the kiln.

The Fauver lubricator consists of a 2-gal. capacity tank hooked up with the plant air line, with an air regulator set at 80 lbs. pressure to insure effective control and operation of the outfit. The air, passing through the lubricator, picks up a predetermined and adjustable amount of lubricant and delivers it, in the form of an oil fog, through ⅜ in. O.D. copper lines to both sides of the chain links. Acheson colloidal graphite is used as the lubricating agent and the mixture and its application are so controlled as to insure each chain pin being lubricated for its entire length every trip and still leave no excess to cause drip. The spray of lubricant is easily adjusted to conform with kiln temperature and with chain speed. The action is entirely automatic. An electric solenoid valve on the lubricator inlet line is wired to the starting switches of the chain drive motors so that the lubricator starts operating the minute the conveyer starts and operates continuously and automatically.



Oven chain lubricator.

In addition to producing uniform conveyor speed and hence more even baking, curing and firing processes, the application of the lubricator is claimed to effect economies in lubricant, a reduction in maintenance costs and an important saving in down time due to conveyor stoppage resulting from improper lubrication.

## Manufacturers' Literature

### New Drying Lamp Booklet

How to apply radiant heat lamps to industrial drying, baking, and heating tasks is told in a new 12 page illustrated booklet published by the Westinghouse Lamp Division, Bloomfield, N. J.

The fundamentals of radiant heat are presented in the first section of this publication, followed by four pages of photographs showing typical drying lamp installations.

Application data, with formulas for calculating the number of kilowatts required to produce the necessary amount of heat, and recommended spacing of the lamps are included. All types and sizes of Westinghouse drying lamps are listed and described.

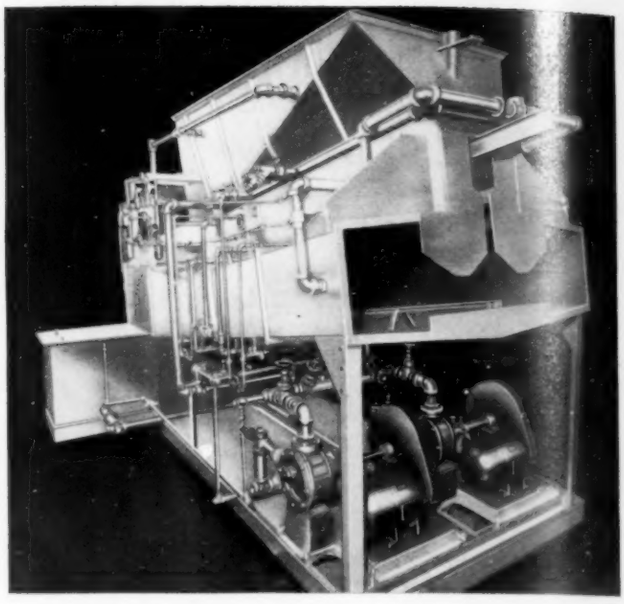
Copies of booklet A-3817 may be obtained from the advertising department of the Westinghouse Lamp Division, Bloomfield, N. J.

### New Wood Grain Booklet

A new brochure describing an improved method of reproducing wood grains on both metal and wood surfaces is being issued this month by Ault & Wiborg Corporation, New York City.

The brochure is enclosed in a special wood grain cover, which is printed in a walnut on the outside and an amboyna burl pattern on the inside. The various applications of the new wood graining method are outlined, and there are illustrations of its use on automobile moldings, on metal furniture, and wall panels, and on the backs of wood brushes.

Manufacturers may obtain copies of the brochure by writing Ault & Wiborg at 75 Varick Street, New York City.

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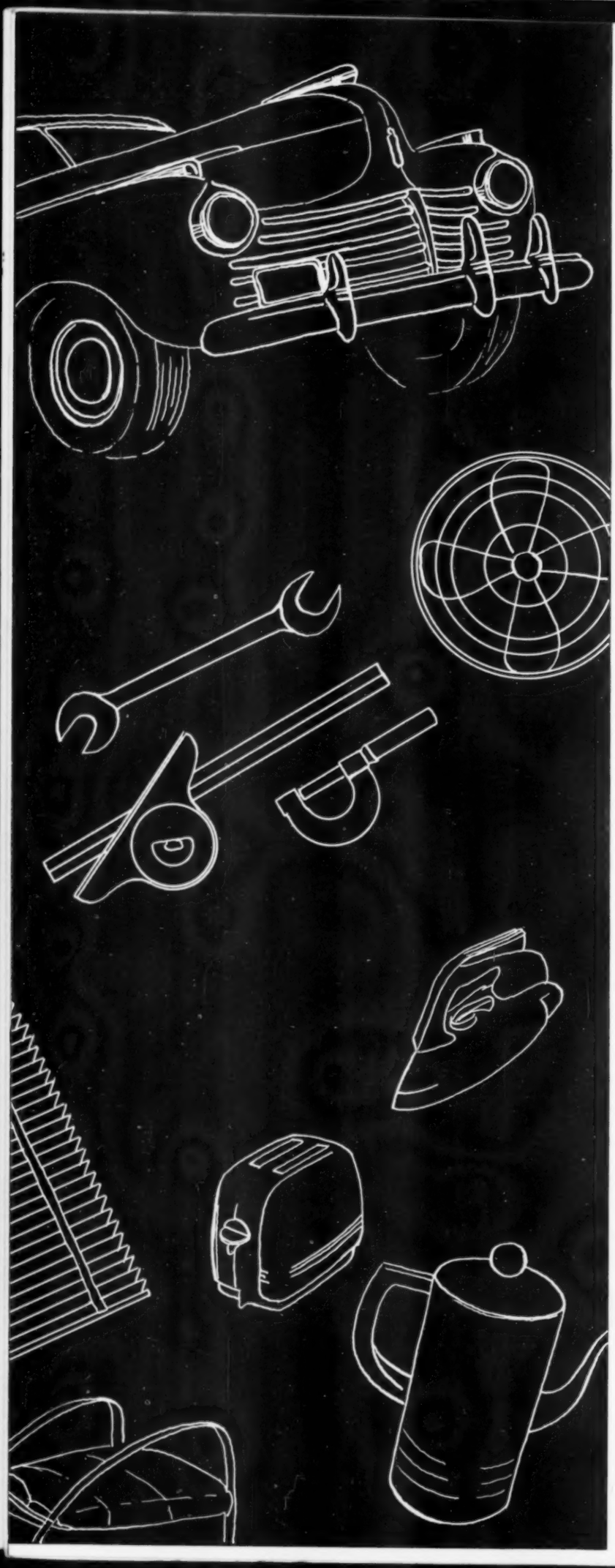

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Our purchasing, sales and technical departments are striving in every possible way to help customers in this period of National emergency. Every effort is being made to keep customers supplied and producing. Research has been intensified in an effort to circumvent the plating problems of the day. . . . This increased activity is sure to result in better materials and methods of plating for the future.

## THE HARSHAW CHEMICAL CO.

Cleveland, Ohio and Principal Cities

VOL. 39, NO. 6 METAL FINISHING JUNE, 1941
PREPARATION, ELECTROPLATING, COATING

# What We Are Facing

The President in his talk of May 27 sounded the keynote of the future—a battle to the end of totalitarianism. Whether you believe in war or not, our entry into it has been a foregone conclusion almost since the first shot was fired in 1938. The United States of today and the immediate future is and will be vastly different than it ever has been, even during the past World War. It should be obvious that full democracy cannot be maintained in fighting wars. Personal liberty and collective liberty have to be sacrificed to attain highest war efficiency and sacrifices will have to be made by the people at home as well as those fighting on the battlefields. True political parties cease to exist and expression of opinion contrary to the ruling party becomes treason. Strikes become treason. The production of consumer goods becomes unpatriotic. These things and many others we will have to face with a smile.

The increase of war effort will require that consumer goods production and consumer goods buying will have to be drastically curtailed to make available adequate materials and labor for defense materials and to retard steady price rise-inflation. Plants, large and small, will either be forced to make war goods, if they can, or go out of business and the latter is already happening. The aim of those directing our destinies in Washington is to eliminate luxury items such as radios, private automobiles, hair curlers, anything that cannot be used in defeat of the enemy. A certain amount may be allowed to be made and the price will be stabilized for them.

There is little hope that the metal and chemical situation will be any better in the near future for the plating industry. Larger demands will be made for metals and other substances used in making armament by plants not yet in operation. In addition, there is little hope that transportation facilities, particularly water shipping, will improve. It appears that mandatory priorities may be placed soon upon steel, copper and in fact, all metals. The list of critical materials will be expanded—cresylic acid, phenol, formaldehyde, cyanides. Our present stock of rubber will last us barely six months and curtailing of shipping from the East Indies would make the rubber situation extremely critical.

The recent rush to buy materials for future use reached the condition of a panic. Markets were thrown out of line by the sudden buying of a year's supply or more of raw materials. Even such substances as glue became relatively tight on the market. This condition has been alleviated somewhat by the allocating of goods by the supplier according to previous records of consumption.

A serious business problem is the maintaining of production by non-defense industries. The trend has been to let these businesses close if necessary—that if they are not producing defense goods, they are using materials and labor which could otherwise be used for defense. The problem of the consumer goods manufacturer is realized in Washington, and the allowing of these industries to close from want of materials would be a serious blow to our economy. Business is greatly interrelated and the stopping of one industry seriously affects others. One hope of the consumer goods industry is sub-contracting for the manufacture of war materials.

The above statements are not made to alarm, but rather to emphasize the fact that severe dislocations of both industry and living will occur and that we must expect them and bear them willingly if our goals are to be achieved. The mechanical war in which we are engaged makes tremendous demands on raw materials —metals, oil, gasoline, rubber, plastics. Civilian use of these and other materials will have to be drastically curtailed. Our way of living and standards of living will have to be changed.

# Industrial Chromium Plating


## BY A. MANKOWICH

*Associate Chemical Engineer*
*U. S. Naval Torpedo Station, Newport, R. I.*



**Review of the subject of hard chromium plating. The author first discusses the various thicknesses to be applied, and then the preparation of the base metal. Comparisons are made between the 33 oz./gal. and 53 oz./gal. solutions in regard to cathode current efficiency, and the 33 oz./gal. solution is preferred for chromium plating. Specific operating details are given for the 33 oz./gal. plating solution. Preparation of the work for plating is outlined, and stress is laid on the reverse current chromic acid treatment of the base metal.**


### *Introduction*

The electrodeposition of chromium has two principal applications—decorative plating and "hard" or industrial plating. The former, as the name implies, is used for appearance and corrosion resistance. Decorative deposits have a thickness of approximately 0.00001"-0.00003" and are usually applied over intermediate deposits of nickel and copper in order to procure corrosion resistance. A.S.T.M. specification A 166-39T requires, for general service on steel base metal, a minimum copper plus nickel deposit thickness of 0.00075" with the final nickel deposit at least 0.0004" thick. The thickness of chromium specified for this combination is only 0.00001" minimum. On the other hand, hard chromium plating for wear or abrasion resistance is applied directly to steel base metal. The thickness of hard deposits varies from 0.0003" to 0.050", but should be at least 0.003" for heavy service.

The factors necessary for the production of a brilliant, corrosion-resistant, non-peeling, decorative chromium plate have been established and are well known to the plating industry. The techniques for hard plating have also been developed, but are not so well known. Such information as is available is conflicting. In this article it is proposed to review some of the factors involved in industrial chromium plating.

### *1. Thickness*

As stated above, the thickness of industrial chromium plating varies usually from 0.0003" to 0.050". The lower end of this range includes many important applications, such as the plating of saws and rubber and plastic molds. Even thinner deposits, also classed as industrial, are applied to drills. After plating, this class of deposit requires buffing only. Such deposits, 0.001" maximum, have been called "flash" plating of the hard type. At the upper end of the range, from 0.050" down to 0.010" approximately, is the field of building up of worn or undersize parts. Between 0.001" and 0.010" is the real field of hard chromium plating. In this range should fall the plating of shafts, spindles, bushings, rolls, gages, etc. Deposits greater than 0.001" must be finish ground or lapped to size.

A. Mankowich

Regardless of rack design or rotation of work, it is impossible to obtain heavy deposition smooth and even enough to permit plated shafts, spindles, etc., to be placed into service minus a finishing treatment. Since finish grinding is necessary, the parts must be ground undersize before plating, plated oversize, and then finish ground or lapped to size.

Experience has shown that a thickness of 0.003" will give satisfactory service as a wear or abrasion resisting coating in most applications. In cases where the deposit must also withstand corrosion, this thickness is insufficient because of the microscopic cracks present in chromium plating. For corrosion plus wear resistance, at least double the normal thickness of 0.003" must be applied. To chromium plate a part for wear resistance, it should be ground 0.006" undersize on the diameter, plated 0.006" oversize on the diameter (thickness 0.006"), and then finish ground to size. It will be found that 0.003" of plating is necessary for the finishing operation.

### *2. Grinding*

Grinding of the steel base metal prior to hard plating can be done satisfactorily with Aloxite A45-M-3100 wheels, using soluble oil as the coolant (a 40-1, water-soluble oil mixture). The chromium plating is finish ground with

finer abrasive, Aloxite 180-R-S30 wheels, using lighter cuts and same coolant. Wheel and work speeds are similar for hardened steel and chromium plating. The wheels may be run at 2200 R.P.M. with the work turning at 200 R.P.M.

### 3. *Solution and Plating Conditions*

The most satisfactory solution for hard plating has the following composition:

| | |
|---|---|
| Chromic acid | 33 oz. per gal. |
| Sulfuric acid | 0.33 " " " |

This solution is operated at 130° F. and 400 amperes per sq. ft. with a 3-inch electrode distance. Satisfactory results are obtained also with the heavier, 53 oz. per gal. solution. However, there are definite advantages to be gained from the use of the recommended solution. Cathode current efficiencies are higher in more dilute solutions, enabling a given thickness of chromium to be plated in a decreased time. For example, at 130° F. and 400 amperes per sq. ft., cathode efficiencies are:

| Chromic Acid, $CrO_3$ | Cathode Current Efficiency |
|---|---|
| 53 oz. per gal. | 13.5% |
| 33 " " " | 17.5% |

Deposits from both solutions under these conditions are of the desired, bright type. While the time factor is not appreciable in decorative plating, it is evident that the above difference in cathode efficiency is of considerable economic importance in the plating of heavy deposits. Thus, for the above conditions:

| Solution Chromic Acid | Thickness Per Hour | Time to Plate 0.006" |
|---|---|---|
| 53 oz./gal. | 0.00107" | 5 hours and 37 minutes |
| 33 " " | 0.00138" | 4 " " 21 " |

These values hold for freshly prepared solutions. It can be shown, that for solutions in use a considerable time, that cathode efficiencies tend to decrease. For example, tests on a 33 oz. per gal. solution, in continuous use for several years, gave the following results at 130° F. and 400 amperes per sq. ft.

| Cathode Current Efficiency | Thickness Per Hr. | Time to Plate 0.006" |
|---|---|---|
| 15.6% | 0.00123" | 4 hrs.—53 minutes |

The more concentrated chromium plating solutions have lower resisitivies than more dilute solutions, and as a result, require lower voltages for a given current density. However, it has been found that this difference is not an appreciable factor for a 33 oz. per gal. solution operated at 130° F. with a current density of 400 amperes per sq. ft. and an electrode distance of 3 inches. A 6-volt generator will maintain a 400 ampere/sq. ft. current density under these conditions. Twelve-volt generators are not required.

It is of interest from an economic standpoint to consider the claims of appreciable savings in power cost made possible through the use of the 53 oz. solution. Since the conductivity of the 53 oz. solution is almost 17.5% greater than that of the 33 oz. solution,[1] it is assumed that the saving in power cost is proportionate. The criterion for most economical operating conditions is not conductivity alone. Experience has indicated that the higher efficiency of deposition in the 33 oz. solution outweighs the disadvantage of higher power consumption due to higher voltage requirements.

An interesting, related development which, however, has found little application is that of hard chromium plating at high temperatures and high current densities.[2] Increased temperature makes possible the use of increased current densities in the bright (hard) plating range. Higher current densities lower the plating time for a given thickness of chromium. Thus, raising the temperature of the 33 oz. solution to 140°-170° F. permits the use of current densities of 900-3000 amperes per sq. ft., the chromium deposits being of the bright, hard type. Tests made on a 33-oz. solution in continuous use for several years, gave the following results:

| | |
|---|---|
| Temperature | 145° F. |
| Current density | 834 amp. per sq. ft. |
| Current efficiency | 14.8% |
| Thickness of chromium per hour | 0.00245" |
| Time to plate 0.006" | 2 hrs., 27 minutes |
| Deposit | smooth, bright |

A freshly prepared 33 oz./gal. solution would give still better results under the above conditions, since the current efficiency would be higher, approximately 20%. The recommended conditions for average practice in this type of hard plating are 1000 amperes per sq. ft. at a temperature of 162° F. It appears, however, that while this technique may be suitable for the plating of small pieces which require relatively small amperages even at high current densities, it is not very practical for the plating of parts with larger surface areas. Parts with large areas to be plated require such large amperages that the heating effect of the current in the solution necessitates refrigeration of the electrolyte.

### 4. *Hardness of Base Metal*

The base metal for heavy, industrial chromium deposits (0.003" thick minimum) need not be harder than Rockwell "C" 30, provided that the corresponding tensile properties meet design requirements. A steel of Rockwell "C" 20-30 has the necessary hardness and strength to form a tough core for the chromium deposit, and, furthermore, is usually free from hardening strains and susceptibility to embrittlement by co-deposited hydrogen.

### 5. *Preparation of Work for Hard Plating*

Successful hard chromium plating is dependent upon close adherence to several factors. All are important for the attainment of continuous success. The three types of factors involved and good discussions of two are to be found in the literature.[2] Briefly, these are: mechanical, metallurgical and electrochemical. The mechanical factors deal with proper racking of the work in accordance with hard chromium plating practice. Considerable ingenuity is necessary for the design of the racks, as well as knowledge and experience gained from actual contact with successful types. Metallurgical factors stress the absence of hardening strains in the base metal. Electrochemical factors are self-explanatory. It is believed that the most important of the electrochemical factors has not been suffi-

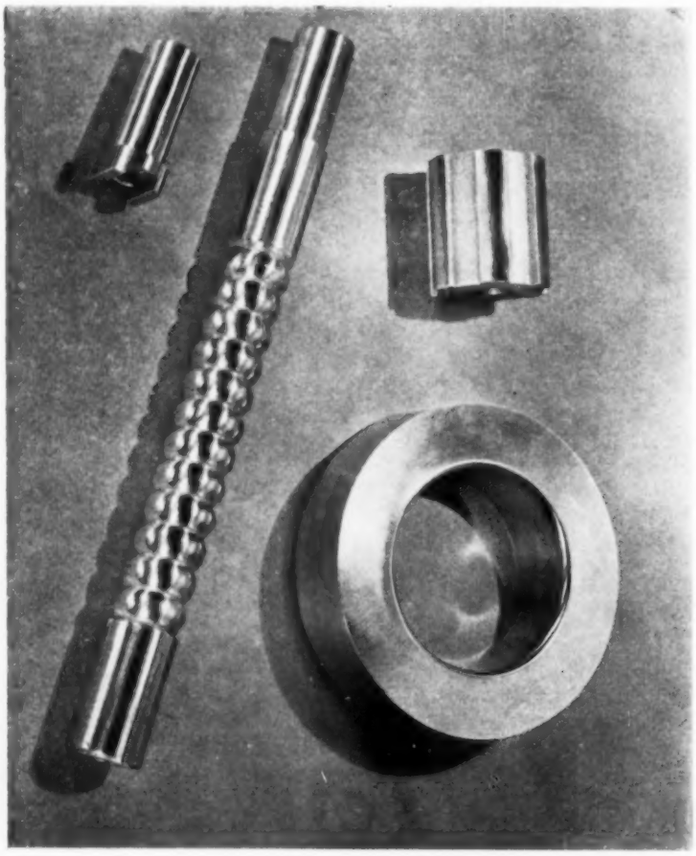

Fig. 1. Chromium plated drawing dies with 0.0015" on a side. Burnishing broach and the quenching plug are also chromium plated.

ciently emphasized in the past. Yet it is probably more important from the standpoint of continuous, successful hard plating than proper racking. This factor is the anodic chromic acid treatment of the work prior to plating. Strict adherence to all necessary rules of hard plating but omitting the anodic chromic acid treatment or substituting an anodic hydrochloric acid pickle, will result in work in which peeling, chipping or cracking of the chromium plate is frequent, either as the work comes from the tank or in subsequent service. Optimum solution and electrical conditions are important, but it is the anodic chromic acid pickle that insures uniform success from the standpoint of adherence of the plating to the base metal.

The chromic acid pickle should be applied in accordance with the following sequence of operations:

(a) Cathodic alkaline electrocleaner, 2-3 minutes
(b) Anodic alkaline electrocleaner, 5 seconds
(c) Hot and cold water rinses
(d) Dip in 18% by volume hydrochloric acid
(e) Cold water rinse
(f) Scrub with No. 100 grit emery paper
(g) Cold water rinse
(h) Rack small work at this point, assembling with auxiliary anodes in place. For large work which requires permanent anode fixtures in plating tank, pass to operation (i).
(i) Anodic chromic acid treatment (details in next section of this article).
(j) Chromium plate. No water rinse between this operation and preceding one.

An important feature from a practical standpoint is the fact that after the work has been given its anodic chromic acid pickle, it can be either put in place in the plating tank with current off while other work is prepared for filling the tank, or the work may be put down on a bench and the film of adhering chromic acid allowed to dry while the remainder of the tank load is prepared.

### 6. *Anodic Chromic Acid Treatment*

The following requirements are believed to insure optimum conditions for anodic chromic acid pickling:

(a) Solution

| | |
|---|---|
| Chromic acid | 29.0 oz. per gal. |
| Sulfuric acid | 0.26 " " " |

(b) Solution temperature—115-120° F.
(c) Voltage—6 volt line voltage is brought directly to the tank, the current taken by work being regulated by its surface area only.
(d) Time—1 to 2 minutes

The importance of the chromic acid electrocleaner cannot be over-emphasized. That it has been recognized by some as a necessary step in hard chromium plating, may be seen from its inclusion in recommended procedures published in 1931 ("Metal Progress", June 1931). It is interesting to note that U. S. Patent 1,645,927 of October 18, 1927, covers the use of an anodic chromic acid treatment of steel prior to chromium plating. The purpose of the treatment, according to the patent, appears to be the production of a surface of uniform passivity in order that subsequent chromium plating may deposit or "throw" uniformly on recessed portions as well as on high relief areas.

### 7. *Racking*

Racking of work for hard chromium plating covers so wide a field that it is intended to cover this subject in a later paper.

# Use of Activated Carbon In Plating

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**A practical discussion on the characteristics and uses of activated carbon are given. The bent cathode method of testing plating solutions for impurities and their removal is recommended. The selective action of various type carbons is mentioned as well as the effects of pH on adsorption. Continuous and batch methods of using carbon are outlined.**

**Case histories of plating solution contamination and the specific methods used in successful purification are described. Supplementary treatments using activated clay and/or chemical oxidation are discussed. —Ed.**

### *Introduction*

THE introduction of bright nickel plating a few years ago brought a need for some simple and effective means of removing impurities from plating solutions. Numerous methods of purification have been suggested, but only a few have stood the test of experience and become generally accepted. One of the most generally applicable is treatment of the solution with activated carbon. While this is effective only where organic impurities are involved, its value may be judged from the fact that many bright nickel plating solutions could hardly be kept going without it.

The idea of using activated carbon to purify plating solutions might seem far fetched, but would not be so to anyone familiar with the numerous other applications of this material as a purifier. These include decolorizing sugar syrup, vegetable oils, fats, glycerine, gelatin, and beverages, removing objectionable tastes and odors from water, wines, whiskey and beer, and purifying many chemical, drug and pharmaceutical products. Each of these applications involves its own peculiar problems, with many of which the manufacturers of activated carbon have become familiar through long experience. The application of activated carbon to electroplating, however, is comparatively new and involves problems about which the manufacturers are unable to supply much specific information. The object of this paper is to bring together such information as is available.

### *Adsorption*

Basically, all applications of activated carbon as a purifier rest on its ability to adsorb impurities present in small amount. Whether the presence of these impurities affects the color, taste, or odor of wine, or the brightness and mechanical properties of electrodeposited nickel, is only incidental so far as the main job to be done by the carbon is concerned.

Superficially, activated carbon looks like powdered charcoal or soot. Both charcoal and soot possess adsorptive powers to a certain degree, but they are very inefficient in comparison with activated carbon. The adsorptive powers of soot are the basis for its use over many years in bright dipping brass. It would be reasonable to expect that activated carbon would be even better than soot for this purpose, and so it seems to be.

### *Origin and Characteristics of Activated Carbon*

Activated carbon is made by carbonizing suitable organic materials in much the same way that charcoal is made by carbonizing wood, only the operation is more carefully watched and controlled and the carbon produced is subsequently treated in order to bring out its adsorptive powers to the fullest extent possible. The great difference in adsorptive power between ordinary charcoal and a good grade of activated carbon reflects the study and effort that have gone into the development of modern activated carbons.

No one has yet succeeded in making a carbon that is equally effective in adsorbing all kinds of impurities. Accordingly, there is no such thing as an all-purpose activated carbon. On the contrary, each activated carbon shows a selective action, and varies in its ability to adsorb impurities with the nature of the substance and the conditions under which the carbon is employed. Selectivity for different types of impurities can be and has been highly developed. It is in this way that high efficiency in purifying by means of activated carbon has been achieved; and it is for this reason that the manufacturers of activated carbon find it necessary to make a number of different grades.

Practically all of the activated carbons used in treating plating solutions up to this time have been carbons that were developed and manufactured for other purposes. The fact that they have proved successful with plating solutions is fortunate, because the total use of carbon in connection with plating is small compared to the tonnage used for other purposes; so if it were necessary to develop special products for this limited application, it is likely that the cost would be higher than that of the carbons now being used.

### *Methods of Testing*

Various ways of testing activated carbons have been suggested, for example, determining the amount of iodine or methylene blue adsorbed. However, in view of the selective action shown by different carbons, the best way

to test a carbon is under exactly the same conditions that will prevail when it is to be used. The results of any such test apply only to the particular carbon tested and to the particular conditions under which the test is made. The fact that a particular carbon has been found good for decolorizing sugar syrup gives little indication of whether or not it will be helpful in cleaning up a plating solution. Nor will the fact that a given carbon removes one type of impurity from a plating solution indicate whether or not it will remove a different type of impurity from the same solution.

If only a single solution and a single impurity had to be considered, testing would be simpler than it is. A few comparative tests would then show which grade of carbon gives the best results. It usually is important to know, however, what grade of activated carbon can be used with reasonable efficiency to handle a wide variety of impurities of unknown nature and origin. This calls for more elaborate testing. It is necessary to test each carbon that is being considered on a number of typical impurities, one at a time. A final appraisal of the carbons on the basis of their all around effectiveness must rest to some extent on experience and judgment, since no series of tests can be made comprehensive enough to embrace all possible impurities.

As for the actual method of testing, plating a test piece in the solution before and after treatment with activated carbon is the only sure way. It is also easy to carry out and gives results that are positive and reliable. Obviously, the plating must be done under standard conditions to insure that the results are reproducible and can be properly interpreted. It is convenient to use a bent cathode made of brass, copper, or steel, three inches long and one inch wide, with a right angle bend one inch from the lower end. This cathode is suspended in a low form beaker of one liter capacity with the short leg of the cathode on the bottom and extending towards the anode; the back of the cathode is placed close to the wall of the beaker on one side and the anode against the opposite wall. The solution should be filtered before treatment with activated carbon, as well as after, in order to eliminate effects due to suspended matter. The test should be made with the solution at the operating temperature, and other conditions, such as pH, properly adjusted. Agitation of the solution or motion of the cathode relative to the solution during plating is desirable, because effects due to the presence of impurities in minute amounts then show up more readily.

The weight of carbon employed in relation to the volume of solution is extremely important. The way to compare different carbons is to ascertain the minimum quantity by weight of each that is required to reduce the impurity in solution to the point where an acceptable deposit is obtained on the bent cathode. In comparing deposits, it is important to note physical properties, such as brittleness, as well as appearance.

Under conditions described above, the plating test is extremely sensitive, and in most cases is more practical than chemical methods of testing. Thus, with certain impurities, effects due to the presence of less than one part per million can be observed. This corresponds to about one pound of impurity in one hundred thousand gallons of nickel plating solution.

### *Selectivity*

Various grades of activated carbon have been investigated by this method, not only for bright nickel solutions, but for other plating solutions as well. Some of the solutions employed were contaminated solutions that had been shipped to the laboratory for examination; in most cases the nature of the impurity was unknown and could not be established without prohibitive effort. In other experiments, various substances were purposely added to pure solutions to study the effects produced, and to compare the efficiency of different activated carbons in removing the impurity. The substances added in this way included brighteners, rubber accelerators, anti-oxidants, dextrin, wetting agents, and a number of other materials which at one time or another had been found to cause trouble.

In general, the results can be summarized by saying that while there was considerable variation in effectiveness among the carbons investigated, a number were found to be sufficiently effective against most of the common impurities likely to be encountered so that these activated carbons could be recommended for general use in plating work. A few of the carbons examined were found to be definitely harmful rather than beneficial; perhaps this was because these carbons had not been properly washed to remove soluble matter.

### *Effect of pH*

In considering the use of activated carbon with nickel plating solutions, the effect of pH is not to be overlooked, particularly if the impurities are basic in nature. In this case, it may be advantageous to raise the pH before carbon treatment. Liscomb's method for purifying nickel plating solutions, which depends on the adsorptive properties of precipitated ferric hydroxide, is usually carried out at a pH above 5 and is occasionally found to be more effective than activated carbon treatment. It may be possible that in such cases the effect of pH may be controlling. On the other hand, activated carbon treatment is frequently effective at low pH, whereas Liscomb's method cannot be used without raising the pH value.

### *When to Use Carbon*

Bright nickel plating solutions are adversely affected by many different kinds of impurities. In fact, this is usually so for all bright plating solutions, regardless of the metal being plated, for bright deposits readily show up impurity effects which would not be visible in dull deposits. In dealing with impurities, it is important first of all to find out whether they are metallic or organic. If they are metallic, activated carbon is not likely to be of much benefit, and other methods of purification must be used. Electrolysis with dummy cathodes at low current density (1 to 5 amperes per square foot) is generally an effective method for removing metallic impurities.[1] Organic impurities, on the other hand, usually respond to treatment with activated carbon.

The variety of organic impurities whose effects can be observed is so wide, the ways in which they may enter the solution so devious, and chemical tests for their presence

[1] Weisberg, Metal Industry, September, 1937.

so uncertain that by far the best practice is to treat the solution with activated carbon regularly, without waiting for impurities to accumulate to the point where purification becomes imperative. Treatment of the solution with activated carbon at regular intervals is a cheap form of insurance against having to stop plating. One of the advantages of activated carbon is that it can be used without interruption to plating. It is therefore possible to purify the solution continuously and thus maintain it in a state of high purity always. Continuous treatment is undoubtedly the way to get the most possible benefit out of activated carbon.

### *Continuous Purification*

Continuous treatment is carried out by circulating the solution through a filter charged with activated carbon. Indeed, whether the treatment is continuous or not, this is the method most commonly employed. One reason this method is favored is that it requires no reserve tank to hold the solution during treatment. Another advantage already mentioned is that it requires no interruption of plating.

The important thing in using this method is to charge the filter with carbon properly in the beginning. The first step is to put a precoat of filter aid on the filter cloths to keep any carbon from slipping through. The easiest way to do this is to make a thin slurry of filter aid and water in a crock, put both inlet and outlet hoses from the filter into the crock, and circulate through the filter until the water in the crock becomes clear. A good precoat is important, because without it carbon may pass through the filter into the plating tank and cause a great deal of trouble. After the precoat has been applied, the carbon is put into the filter in the same way as the filter aid. However, if the water coming out of the filter looks dark or is not perfectly clear, it indicates that the precoat is not effective and that carbon is coming through. In that case, the best thing to do is to wash out the filter and start over again with a new precoat.

After the carbon has been put into the filter, the plating solution is circulated through it. The amount of carbon to use depends on the circumstances. If the solution is badly contaminated, it may require as much as 30 to 40 pounds of activated carbon per 1000 gallons. If the solution is only slightly contaminated, or if the treatment is simply part of the regular routine to prevent accumulation of impurities, the amount of carbon may be reduced to 5 or 10 pounds per 1000 gallons. In case of regular or continuous treatment, the rate at which impurities are entering the solution determines how much activated carbon should be used.

In this connection, it is worth while to bear in mind that the most effective use of activated carbon is obtained when the charge in the filter is not too large and is renewed fairly often. For example, two successive treatments with 20 pounds each time gives better efficiency than a single charge of 40 pounds. Where the filter is capable of holding a large amount of carbon, there is a tendency to put in as much as it will hold so as to avoid having to clean the filter any more than is absolutely necessary. Better efficiency in utilization of the activated carbon can be obtained by using less at a time and cleaning the filter more often. On the other hand, when a solution is badly contaminated and speed in removing the impurity is the prime consideration, as much carbon should be used as the filter permits.

### *Batch Treatment*

When an extra tank for treating the plating solution is available, the plating solution may be pumped into the extra tank, agitated for an hour or more with activated carbon, and then pumped back into the plating tank through a filter. This practice is not to be recommended unless the extra tank is suitable for the solution; to use the wrong kind of tank may undo all the good that purification might accomplish. It is desirable that this tank should be fitted with an agitator to bring about thorough mixing of the carbon with the solution, and with suitable means of warming the solution. Treating the solution with activated carbon when it is too cold greatly increases the time required to adsorb impurities. Finally, the filter should be precoated with filter aid as described before.

There is still another way to treat plating solutions with activated carbon, but it should be avoided except as a last resort. This method is to put activated carbon in the plating tank, mix it with the solution, and then circulate the solution through a filter to remove the carbon. The objection to this method is that carbon adheres tenaciously to everything that it touches, and it is very difficult to take the last traces of it out of the plating tank. Carbon adhering to the sides of the tank gradually works loose and produces rough deposits. It is a good rule, therefore, never to let carbon get into the plating tank.

### *Case Histories*

The following case histories and observations give some idea of the types of materials that can be successfully removed from plating solutions by proper treatment with activated carbon.

Oil from a generator located above the nickel plating tank overflowed from the drip pan into the solution below. The top of the solution was covered with a layer of oil and an oil film also spread over the inside of the tank above the solution. Some of the oil floating on the solution was removed by skimming the surface with adsorbent paper, and the balance was taken up by means of activated carbon. In this instance, the carbon was put right in the plating tank, which is ordinarily not the thing to do; however pumping the solution through a filter charged with carbon did not look like an effective means of catching the floating oil film. A jet of steam directed along the sides of the tank near the top drove the oil film down onto the solution where the carbon gathered it up. After the solution was filtered, it gave just as good results as it had before it became fouled by the oil.

In another case, polishing grease was being packed into inside recesses of the pieces where the sprays from the washing machine could not reach it. As a result, the nickel deposit was coming out cloudy instead of bright. The cloudiness was overcome by circulating the plating solution through a filter charged with activated carbon. Regular treatment of this kind proved necessary, because the grease was being carried into the plating tank steadily, and if it was allowed to accumulate too far, the same condition returned.

In another case, a nickel solution was so badly con-

taminated that the cathode current efficiency had become practically zero. This came about through putting the solution for temporary storage in a wood tank which had just been coated on the inside with several thick coats of a Bakelite varnish. Filtration of the solution through activated carbon removed the impurity so that the solution was operating satisfactorily again within a few hours. Experiments with the Bakelite coating showed that the trouble was due to the fact that it was not allowed to dry properly; in other words, the trouble was due to the presence of unevaporated solvent rather than to the Bakelite resin.

Only a comparatively few possible impurities have been mentioned thus far. Soap, rosin, sizing in filter cloths, anode bags, and paper liners in barrels, water soluble matter extracted from rubber such as accelerators and anti-oxidants have all been known to cause trouble. The same holds for decomposition products formed from some brightening agents. Here the problem is to take out the harmful decomposition products without taking out too much brightener. The same considerations apply to the removal of objectionable bodies formed from certain wetting agents.

Wetting agents can be taken out readily with activated carbon. Their removal can be readily followed by surface tension measurements. It takes only a light treatment with carbon to bring the surface tension up to what it would be with no wetting agent present. However, products formed from certain wetting agents as a result of electrolysis or decomposition are less easy to deal with and may require additional treatment. For example, a solution in which a well known wetting agent had been used for a number of months began giving very brittle deposits, which in addition were burned in the high current density areas. Treatment with activated carbon removed the wetting agent but did not overcome the trouble. Treatment of the solution with potassium permanganate was finally necessary in order to destroy the decomposition products.

### *Supplementary Treatments*

In some situations, activated carbon is more helpful if the impurity is subjected to chemical treatment first. For example, speedier purification would probably have been obtained in the foregoing case if the permanganate treatment had been used before carbon treatment, instead of after. This is confirmed by a recent experience with a contaminated solution which was producing extremely brittle deposits. It was first treated with potassium permanganate (one tenth ounce per gallon), the manganese dioxide formed filtered off, and the solution then treated with carbon. The brittleness was eliminated.

Treating the solution with hydrogen peroxide before using activated carbon has proved successful in a good many cases and usually involves less filtration than treatment with permanganate. The 100 volume strength is employed, and since an excess does no harm, it may be used generously, say 1 gallon of 100 volume peroxide to 100 gallons of solution. After the peroxide has acted on the solution for a few hours, it is treated with activated carbon. Any excess of peroxide that may be left should be destroyed by heating the solution to about 160° F. for a few hours.

Removing organic impurities from plating solutions is still based largely on trial and error methods. Whether activated carbon is best used alone, or in conjunction with hydrogen peroxide or potassium permanganate, usually has to be determined by experiment in any given case. A few bent cathode tests such as have been previously described usually save time and trouble in the long run.

Activated clay is a useful adsorbent, although it does not have the wide applicability of activated carbon. Activated clay though does adsorb some impurities that are not removed by activated carbon, and its use in conjunction with activated carbon is therefore sometimes recommended on this account.

Sometimes electrolysis may have an effect on the ability of activated carbon to remove an impurity. A preliminary electrolysis at low current density sometimes makes it possible to adsorb an impurity when activated carbon is ineffective before electrolysis. Likewise, the opposite effect is sometimes encountered, namely, electrolysis may put the impurity into a condition where it can not be adsorbed. In most of these cases, the nature of the impurity is unknown, and there is no way to tell whether oxidation at the anode or reduction at the cathode is responsible for the effects produced by electrolysis.

In any event, treatment with activated carbon first produces no detrimental effect, regardless of what impurities are present, whereas nearly all other methods of purification may do unpredictable mischief unless they are first tried out on a small scale or the nature of the impurities is known.

As pointed out in the beginning, the general use of activated carbon in connection with electroplating began with bright nickel plating solutions. Its success in this field has led to the treatment of other plating solutions with marked benefit. For example, Rochelle salt copper plating solutions, which are often used to produce a copper undercoating for bright nickel, give "grainy" deposits when contaminated with soap-like materials or grease carried over from the cleaners. Impurities of this type are readily removed by treatment with carbon. After such treatment, the Rochelle salt solution gives deposits that are much smoother.

Nearly all cyanide plating solutions are sufficiently alkaline to emulsify any grease or oil that may be carried on the work, and accordingly give better results when these materials are taken out by treatment with activated carbon.

Acid copper solutions are affected by organic materials, such as rubber accelerators and anti-oxidants, for example. The effects show up sometimes in the appearance of the deposits; more often the deposits buff less easily than they should. Treatment with activated carbon is often all that is necessary to produce normal behavior.

There is hardly any plating solution, in fact, which is not affected in some degree by the presence of organic impurities. Experience indicates that in a majority of cases where organic impurities are involved, improved performance can be obtained by proper use of activated carbon.

# The Chromic Acid Anodizing Process†

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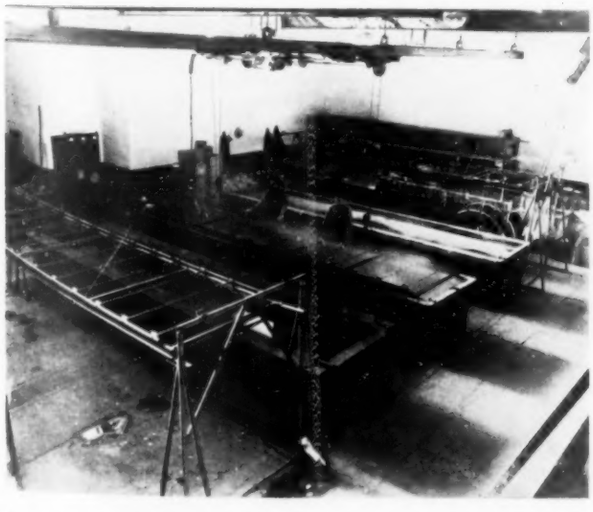
**The author thoroughly discusses the chromic acid anodizing process for treating aluminum alloys. The mechanism of the formation of the oxide film and the nature of the film are considered at length. Methods for maintenance and control of the chromic anodizing solution as developed in practice at the Lockheed Aircraft Corporation, are given.—Ed.**

### *Introduction*

The increased use of aluminum and its alloys in recent years has invaded fields of industry where the products must resist the corrosive action of the most unfavorable conditions of climate or the effects of impure industrial atmospheres. Of the various industries not themselves connected with the producers of aluminum themselves, the aircraft manufacturing industry is perhaps the most critical and exacting in its demands that surface finishing methods afford the best possible assurance of corrosion free service.

Of all the known methods of surface protection, some form of anodic treatment in conjunction with inhibiting types of paint films seems to afford the most satisfactory and easily applied means of securing the desired results. Because of its general acceptance as the best method of surface anodization for general use in the aircraft factory, this discussion will deal almost entirely with the chromic acid method.

The formation of oxide coatings by anodic processes is not new, the first recorded use being by Buff in 1857 by the employment of sulfuric acid as the electrolyte. His failure to realize that the coating so formed was an oxide probably explains the lapse of some forty years before the first patents were issued in 1898 in England to Pollak who used a mixture of soap and potassium dichromate as his electrolyte. These first uses of anodic films on aluminum were for the purpose of valve action in electrolytic rectifiers or condenser construction and not for the purpose of surface protection.



General view of anodizing shop showing progressively, the assembly table in the rear, the precleaner tank, a rack being loaded, the cleaner tank, a load of work in the rinse tank, the anodizing tank, and finally the unloading rack in the immediate foreground.
*(Courtesy, Lockheed Aircraft Corp.)*

The first patents covering the use of chromic acid for the purpose of forming protective films of aluminum oxide as a means of obtaining resistance to corrosion were issued in England to Bengough and Stuart in 1923. Their process with only slight changes forms the basis of the present methods employed in America for the chromic acid anodizing of aircraft parts. In general, their method was to place the aluminum parts to be treated in a 3% solution of chromic acid in water. The container, usually made of steel, was then made the cathode and the aluminum parts, the anode, and the voltage applied was gradually increased to 40. After holding at 40 volts for 35 minutes, the voltage was increased to 50 volts for 5 minutes which ended the process and resulted in the formation of a very heavy gray coating of aluminum oxide. The double step voltage method produced such heavy films that no further protection was thought necessary and very good service has been obtained in many instances.

The original Bengough process was, however, an expensive method due to the high consumption of electric current and chromic acid, and the single step or constant voltage process of operation has almost completely replaced the older method in this country.

Due to the patent situation and the requirements of certain government specifications, the use of either a 3% or a 5% chromic acid content was required at the start of a new solution. The temperature was required to be kept at 91 to 99° Fahrenheit and the voltage to be kept at 40 volts for 30 minutes after a slow rise from zero volts to 40 volts at the rate of 8 volts per minute. A final rinse in hot water (approximately 160° F.) completed the process by setting the oxide film that had been formed.

In order to understand more completely the formation of these oxide coatings, we must visualize what actually happens during the anodizing of an aluminum surface. Several theories of how the oxide film is formed have been advanced, but the one that seems the most simple and at the same time the most logical may be described as follows.

† Presented to The American Electroplaters' Society, Los Angeles Branch Annual Educational Session, March 22, 1941.

### *The Formation of the Oxide Film*

The chromic acid radical is attracted to the positively charged aluminum surface and there liberates a portion of its oxygen which, in turn, forms an oxide of aluminum in a very finely divided form that adheres very securely to the aluminum surface. The chromium then goes back to its position as part of an acid radical since the reaction is very similar to the electrolysis of any acid solution resulting in the breaking up of water and the liberation of oxygen and hydrogen. At this point, however, the similarity ceases and other factors begin to enter into the procedure. The acids present will be both chromic and dichromic and will be capable of reacting with the aluminum oxide that has been formed, and by so doing produce chromates and dichromates of aluminum, chromium and a series of double salts of aluminum and chromium to say nothing of the basic salts of all these combinations.

The dissolving action of the acids present may in the case of a very weak concentration be so slow that an extremely thin film of oxide may completely insulate the surface from the effect of the solution and stop the action before sufficient oxidation has occurred to be of any benefit. Then again, the opposite extreme of high acid concentration and its rapid dissolving action may completely remove the oxide film as fast as it is formed. In both cases no appreciable oxide coating results and the process would be considered to be inoperative.

In the proper concentrations of acids, the dissolving action should be sufficient to produce small pores through which the contact between aluminum and the electrolyte may be maintained without excessive removal of the oxide layer. This will then result in a growth of oxide film by continued action of the aluminum surface until the combined valve (rectifying) effect and the resistance of the oxide layer approach the value that will allow almost no further action to take place. Current will, of course, continue to flow but the oxidation and dissolving actions reach an equilibrium in about 30 to 40 minutes and continued operation of the process of little additional benefit.

From the above, it will be seen that by controlling the acid concentrations, one may produce coatings of any desidered porosity and thickness and so obtain any degree of pore size needed for any particular application. As an example, films formed in a new solution containing 6% chromic acid have been found to be about 0.0001" in thickness and of a porous nature, while those formed by a new 3% solution measure only about 0.00004" in thickness but are much less porous or of a much more impervious nature. Any concentration of acid between 1.5 and 3% seems to produce very similar films. In fact, films formed at the lower concentrations, resulting in a current density of approximately 1 ampere per square foot of area being anodized, is the desired result upon which the writer's studies of shop control have been based. Acid concentrations that will provide conductivity permitting a current density of 0.90 ampere per square foot will anodize satisfactorily, and surfaces so processed will pass the 720 hour salt spray test now required by governmental specifications. This current density is about the minimum point at which satisfactory results can be obtained. However, any concentration of acid that results in high current density is not economical to operate and will result in reduced shop production capacity attainable with any given source of current supply. Since direct current is required, the source is generally a motor-generator set of limited ampere capacity.

### *The Nature of the Anodic Film*

Before going further, some attention should be given to the nature of the coating formed and some of the present studies regarding its chemical composition. Recent investigations using X-ray diffraction methods have shown the presence of both amorphous aluminum oxide and the alpha crystalline hydrated form known as Bohmite ($Al_2O_3 \cdot H_2O$). In the case of the fine grain nonporous types of film, the grain size has been found to be so small that there would be no essential difference between colloidal or crystalline material. Along with the oxide of aluminum will also be oxides of any alloying constituents that are easily oxidized. Some of the substances usually present in aluminum alloys such as silicon and manganese-aluminum will be present as occluded particles imbedded in the aluminum oxide and will tend to color the anodic films. A coating of pure aluminum oxide is practically colorless or only slightly irridescent but the impure coatings formed on the various alloys may vary from a light gray to almost black.

Since the anodic film consists of a myriad of fine pores, it may be extremely absorbent in its nature and may readily absorb a considerable quantity of any coloring matter with which it comes in contact and often advantage is taken of this fact for producing ornamental effects. In obtaining paint adhesion, the very fact that some of the chromic acid always remains in these fine pores adds materially to the corrosion resistance of surfaces so treated. The amount of chromic acid to be found in the anodic films will vary somewhat with the pore size and has been estimated by C. Aribault as 0.041 mg. of $CrO_3$ per square meter of anodized surface.

### *Maintenance and Control of Any Anodizing Solution*

After a period of use, any chromic acid solution ceases to function after the current density has gradually dropped to a value of about 0.9 ampere per square foot and additions of acid are necessary to obtain satisfactory operation. Much study has been made of the causes that result in the depletion of the solution's activity. Most authors have concluded that the formation of aluminum dichromate and the reduction of the chromium to the trivalent state are responsible, and various methods of maintaining a uniform condition of operation have been suggested.

An opportunity to study the changes taking place in the anodic bath in operation at the Lockheed Aircraft Corporation afforded a large quantity of data that were carefully tabulated and studied with some rather unexpected results. First of all, almost no trivalent chromium was found whenever the strength of acid was adjusted so that a current density of approximately one ampere per square foot could be maintained.

If the acid content was high, a small tendency to form trivalent chromium was evident but that small quantity would be rapidly oxidized again as the acid activity was reduced. In other words, trivalent chromium was not ordinarily present. Whenever new boards were added to the lining of the tank, the presence of organic compounds

always resulted in some trivalent chromium which did not revert to the hexavalent state but seemed permanently out of action.

An attempt to correlate the percentage of aluminum did not check the results of the Bureau of Standards Report (Research Paper RP961, "Deterioration of Chromic Acid Baths Used for Anodic Oxidation of Aluminum Alloys" by R. W. Buzzard and J. H. Wilson) in which failure of the bath was explained in terms of the presence of aluminum compounds. As far as can be learned, no detailed study has ever been made of all the various possible combinations of the normal and basic salts of aluminum which are possible in an anodic solution but an attempt has been made to show that the presence of free chromic acid may be judged by the pH of the solution. Any relation between the percentage of free chromic acid and the operating condition of an anodic bath does not exist in the author's opinion, since the pH of a solution controlled so as to maintain the current density at one ampere per square foot will, after the first few days, be a value above 2. Since a pH of 2 is supposed to indicate zero percentage of free acid, it is evident that free acid is not necessary, and good results are possible in a complex electrolyte composed of the various compounds formed in the anodizing bath. In fact, calculations based on the proposed formula:

$$\frac{\%Cr_{VI} - (5.8 \times \%Al + 3 \times \%Cr_{III})}{0.52}$$

actually gave negative answers for the free chromic acid and so confirmed the conclusions drawn from the pH values. After the anodizing bath has been in use for some time, the values calculated from the above formula will average from —1.50% to —1.65% of $CrO_3$, or in other words, it would take about 1.5% of pure $CrO_3$ to restore the bath to "zero free acid content".

Probably there is a definite relation between the amount of hexavalent chromium, the pH and the content of aluminum as regards to the condition of the solution, but the complexity of their relationship has not been completely explained so far. The presence of the colloidal double dichromates of aluminum and chromium have not been found in the solutions studied at Lockheed as is shown by the absence of trivalent chromium but some colloidal material does become evident when the concentration of total chromium is about 7.5% expressed as $CrO_3$ and settling is very noticeable at that time if the activity of the bath is such that the 1 ampere per square foot is still maintained. At about this point, extra acid additions are necessary to again form normal salts and to prevent loss of activity of the solution. This, of course, is not economical if carried too far and usually the point of maximum efficiency will be shortly beyond that point, usually at approximately 10% $CrO_3$ and a new bath will be advisable.

A normal efficiency curve as followed at Lockheed Aircraft is shown in Figure 1 and, as will be noted, a normal solution may be expected to reach a maximum of 319 ampere hours of use per pound of acid, after which point a drop is usually observed due to greater dragout losses at the higher concentrations and the abnormal consumption of acid needed to maintain satisfactory operating conditions. This curve has been calculated mathematically and

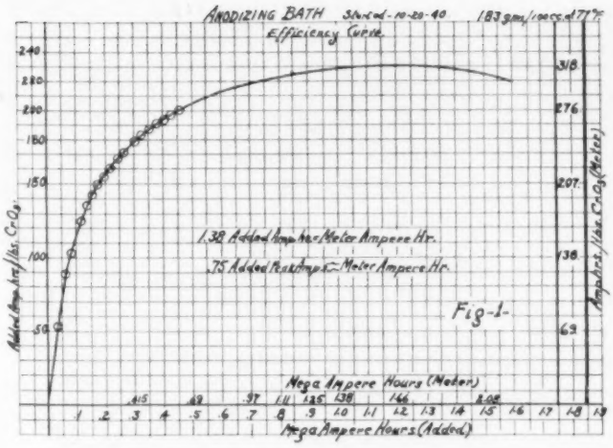



Fig. 1. Efficiency curve for anodizing bath.

plotted together with actual operations curves for several baths covering the operations of a 4,000 gallon installation and the resulting Figure 1 is now used as the ideal upon which to base shop control.

Several attempts have been made in the past to find some easy method of keeping the anodic solution at a constant activity and consisted of pH control, specific gravity versus per cent chromium and conductivity measurements. Some success has been attained in each case, but the former requirement that at least 5% acid be present prohibited any attempt to begin at low acid concentrations and to make acid additions in such manner as to

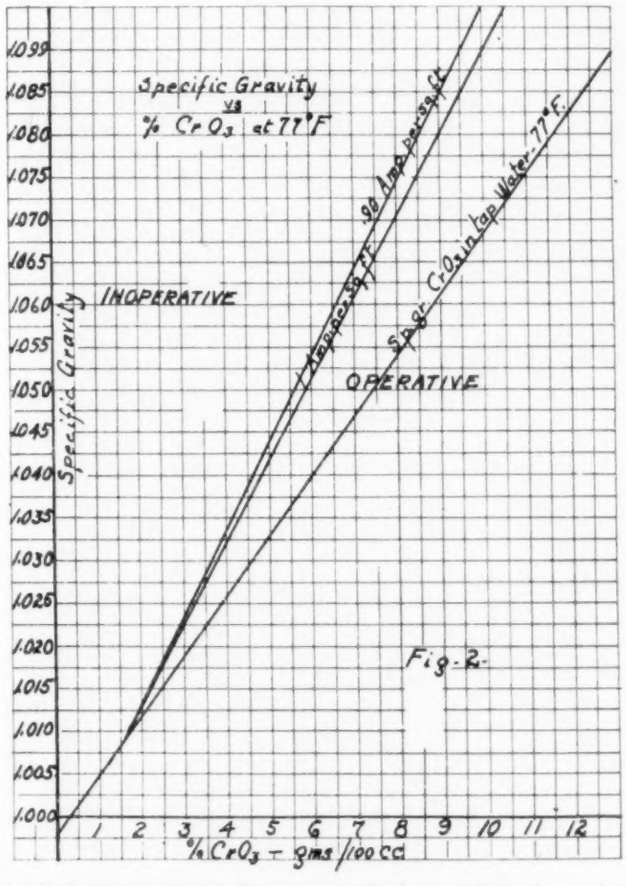



Fig. 2. Specific gravity of chromic acid solutions at 77° F. Curves show difference in specific gravity between new and used baths.

keep a constant current density during the whole life of the solution. Due to the fact that Lockheed was not working on Government contracts at that time, a complete investigation of the various methods of control was possible.

Several factors led to the decision that operating below 5% acid was desirable. Among these may be mentioned: ability to carry loads of large area without increasing generator capacity, reduced acid consumption, uniformity of results, the advent of the idea that a thin non-porous film for paint adhesion was as satisfactory as the time-honored heavy gray coating, and the observation that it was actually more difficult to remove the thin film by stripping agents than to remove the heavy type films. In fact, a French delegate had reported to the Royal Aeronautical Society some two years ago that his experiments showed the thin denser films to be much superior in service. The very general use of the inhibiting type primers in addition to the anodic coatings insured satisfactory service life even for the thinnest protective films. In fact, such thin films will pass the 720 hour salt spray tests without difficulty and will satisfy the corrosion requirements of the Government specifications as they now exist.

Since the 720 hour test represents only a small portion of the service life normally expected from an airplane, it is obvious that the anodic coating is to be considered as a means toward securing protection rather than as the protection itself.

Keeping an exact control of all acid additions for several months, and plotting the use obtained from each addition against the acid added, resulted in the curve shown in Figure 3. This was found to be quite consistent for the life of several solutions and from this it was evident that starting the bath at an acid concentration far above the curve for the initial operation and then following the slope of the curve for the remainder of the life of the bath, is a rather unscientific procedure to say the least.

Since the present British method of control is based upon the change in specific gravity during the operating life of the solution, a study was made of the differences between fresh solutions of various acid contents and the baths that contained the same total chromium but in the used condition. A graphic picture of these values is given in Figure 2, and the determination of satisfactory solution conditions can be very easily and definitely established by reference to the curves. It will be further noted that the line of specific gravity of the pure acid crosses the line of operation at about 1.5% $CrO_3$, and this is the lowest percentage of acid at which good results (one ampere per square foot) are obtainable if we are to maintain the same level of conductivity throughout the life of a solution. Assuming this minimum point and using it to establish the low point or beginning point of the basic line in Figure 3, we have only to continue the line through the point at which the maximum efficiency of the bath was found and so produce the basic line itself as shown in Figure 3. The British method of adding acid as needed until the specific gravity reaches 1.058 or Baume 8° and then replacing the solution would not result in reaching the efficiency obtainable by carrying the additions of acid much further. In fact, very good results have been obtained at specific gravity of 1.080 and the need for a new solution is believed to be a matter of acid efficiency and economy and not determinable by specific gravity readings only.

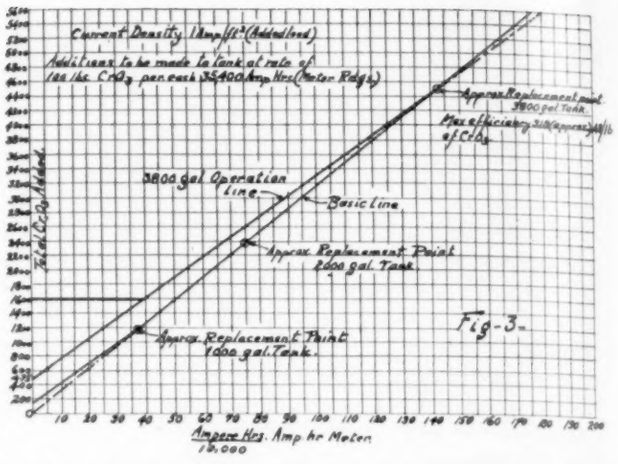



Fig. 3. Basic line for practical operation and maintenance of chromic acid oxidizing solution.

Graphing pH against acid content at points of equal current density values resulted in the curve shown in Figure 4, but attempts to reproduce the results with other solutions have failed; and, in the author's opinion, the use of pH values for either control or indication of the necessity for changing the solution is unreliable and uneconomical.

After consideration of the above results of a study to determine a reliable method of control, the use of the operation line shown in Figure 3 was considered to be the

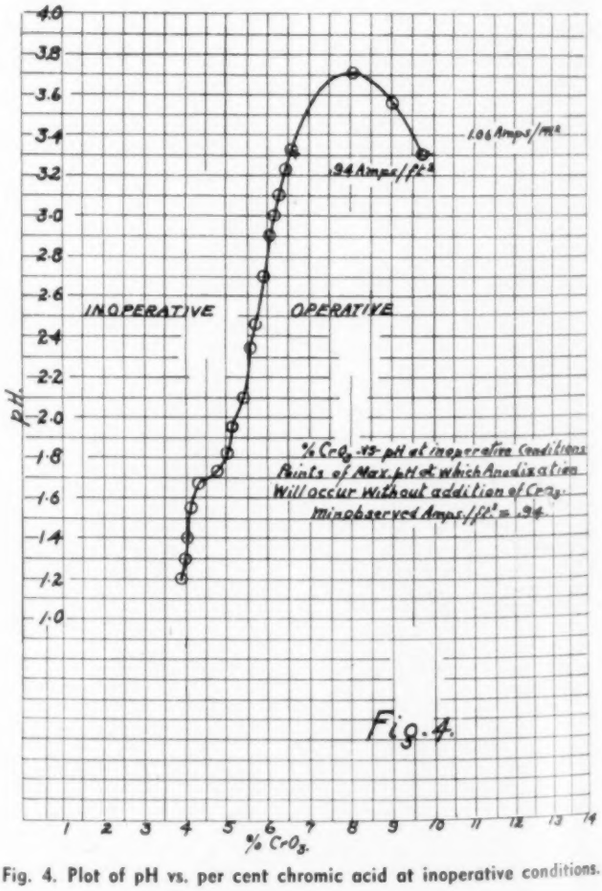



Fig. 4. Plot of pH vs. per cent chromic acid at inoperative conditions.

more easily applied in actual shop practice; and after following this method for a period of approximately a year throughout the lives of several solutions, we have firmly established the accuracy of the method. For a 3800 gallon tank, an initial concentration of 1.83% of $CrO_3$ is used, and since 100 pound additions are made as a matter of convenience, acid is added after each 35,400 ampere hours of use. For smaller units, lines parallel to the line shown in Figure 3 may be drawn and used as control curves. In such cases, the anodizing solution will reach its maximum efficiency and require replacement at correspondingly lower total ampere hours of operation.

### *Dragout Losses*

All of the curves which have been discussed so far have disregarded the loss of acid by dragout. It has been found that the loss by dragout will be approximately 28% to 30% of all the acid added during the entire life of the solution provided the concentration has been maintained according to the operations curve shown in Figure 3. In general, higher dragout losses will be incurred at the lower current densities due to the greater surfaces anodized per pound of acid.

### *Operating Costs*

The consumption of acid based upon the method of control proposed above will be approximately 2.2 pounds per 1000 square feet of surface anodized. By surface anodized is meant the total area of all the exposed faces, or in the case of sheet work, both sides are counted. At the present price of chromic acid, this will mean an expense of 44c approximately for 1000 square feet of surface anodized.

During the process of anodizing 1000 square feet of surface, approximately 30 kilowatt hours of electricity are consumed. The cost of current will, of course, depend upon the power rate. As an example, at 2c per kilowatt hour would indicate an expenditure of 60c for electricity for 1000 square feet of anodized area.

### *Summary and Conclusions*

The foregoing discussion is based on anodizing aluminum and aluminum alloys for surface preparation prior to application of paint coatings and much larger current densities may be desired for other purposes. In fact, thick films are often used for insulating electric condensers, for resisting abrasion, for absorbing dyes or other coloring matter for ornamental uses, or for changing the heat or light absorbing or radiating properties of the surfaces. In all such cases, solutions may be maintained for a few weeks at the desired current densities for producing the desired properties of the oxide coating and then operation curves can easily be established for acid control similar to those given in this paper based on a lower value of current density. It is believed that the method as outlined can be made quite flexible and curves can be very well established to fit any desired condition.

In closing, it should be kept in mind that there is still much room for further study in matters concerning solution breakdown and shop methods of control, methods of recovering the chromium from the aluminum compounds, removal of aluminum, and other factors entering into the operation of a chromic acid anodizing bath, but the following brief summary is offered as a practical solution of acid control that can be easily established as a shop practice.

1. Start a new chromic acid anodizing solution with 1.50 grams per 100 cc. (2 oz. per gal.) of $CrO_3$ in tap water plus whatever quantity of acid you may decide as the most convenient quantity for regular additions.

As an example we add 475 pounds plus 100 pounds or a total of 575 pounds of acid to start a new bath. This gives a concentration of 1.83 grams per 100 cc. (2.45 oz. per gal.) in a 3800 gallon tank.

2. Add acid at the rate of 100 pounds for each 35,400 ampere hours of use as measured by an ampere hour meter. Smaller additions may be made as desired just so the same ratio of acid to current used is maintained. This will keep the conductivity of the solution such that the current density will approximate one ampere per square foot of aluminum surface and a slightly higher current density for the various alloys.

3. When the acid has reached the concentration of approximately 10 to 11 grams per 100 cc. of total chromium calculated as $CrO_3$, the solution should be dumped and a fresh one started. This point is not critical but continuation of the bath beyond this value will not result in any gain in use per pound of acid and a slight drop in efficiency of the bath expressed in ampere hours per pound of acid will follow. This drop is not abrupt and temporary shortage of material for beginning a new bath is thus not a matter for great concern. A solution may be kept a reasonable additional period of operation if necessary.

For those not having an ampere hour meter available, it is an easy matter to set up a control curve based on a figure obtained by adding the amperages drawn by the individual loads of parts being anodized. The readings should be taken toward the end of the cycle after the amperage has become fairly steady. When the sum of the amperages has reached the required figure, additions of acid should be made. Due to the high amperages during the initial application of current, it is not correct to assume that a ratio of $\frac{32.5}{60}$ can be used to calculate the ampere hours for determination of acid requirements. Experiments and records covering a considerable period of time show that the values are slightly different when running heavy loads from those found from the readings taken during light loads. However, for all practical purposes, one may assume Amperage Sum $\times$ 0.75 = Amperage Hours by meter readings, and the control curves may be established on this basis. When such summations are used, it will be found that acid should be added at the rate of 100 pounds for each 47,200 added amperes. Operations at Lockheed have been successfully conducted using both the additive and the meter methods with equally satisfactory results.

For an illustration, Figure 1 is shown in both added amperes and ampere hours by meter readings.

# Surface Tension Measurements

## PART III—Conclusion

BY DR. C. B. F. YOUNG† *and* E. S. ROSZKOWSKI‡

**This is the concluding portion of the article, first part of which appeared in the April issue, and the second part in the May issue.**

Continuing this type of calculation for the values given in the table, the equilibrium point for each set of values is obtained. The mean of the three sets for any given weight is taken as the equilibrium point for this weight, or in other words, if the displacement from the equilibrium is equal to this value, a correction in weight must be applied which is equivalent to this displacement.

From the above data, the sensitivity of the balance is 1.53 divisions per milligram. Due to the small angle of displacement which covers the entire scale, the sensitivity is approximately constant and will be taken as such. As mentioned in a previous paragraph, when the equilibrium point is to the right, the displacement will be marked negative and thus its relative correction must be subtracted. The reverse holds in the case of displacements to the left.

The calculations herein used are the same kind that were performed in the case of the Du Nuoy tensiometer except for the difference in the circumference of the ring which is 5.2 cm. instead of 5.997 cm. as in the former. Here the reading will be obtained directly in grams and must not be converted from the scale readings as in the case of the tensiometer.

The arrangement consists of a ring suspended by a wire from the beam. (See Figure XIV.) A table is furnished upon which the watch glass can be placed and is so constructed

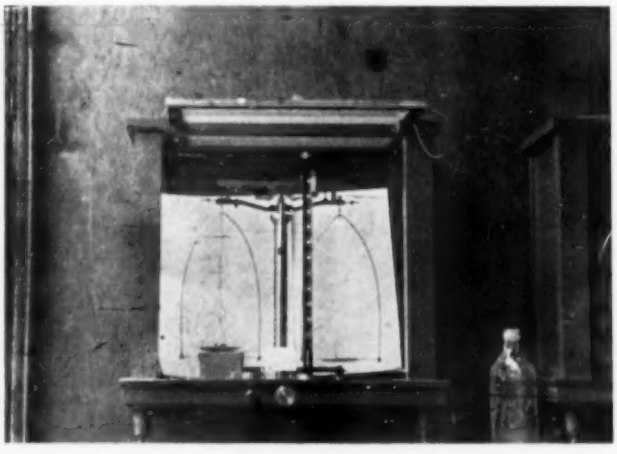


**Fig. XIV. Photograph of balance used for determining surface tension by ring method.**

**Determination of Surface Tension by Chemical Balance at 20° C.:**
**$K_2Cu(CN)_3$ Solution**

| Conc. oz./gal. CuCN | Ring | Reading in Grams | Tare Upon | Correction in Divisions |
|---|---|---|---|---|
| 7.54 | Pt | 1.524 | 0.761 | —7 |
| | Ni-Cr | 1.365 | 0.632 | —5 |
| 5.66 | Pt | 1.548 | 0.744 | 3 |
| | Ni-Cr | 1.407 | 0.616 | —1 |
| 3.77 | Pt | 1.560 | 0.761 | —2 |
| | Ni-Cr | 1.456 | 0.634 | —2 |
| 1.89 | Pt | 1.548 | 0.744 | —4 |
| | Ni-Cr | 1.481 | 0.634 | —2 |
| 0.00 | Pt | 1.539 | 0.743 | 0 |
| | Ni-Cr | 1.490 | 0.613 | —3 |

Sample calculation for Pt ring in 7.54 oz./gal. solution of $K_2Cu(CN)_3$

| | |
|---|---|
| Reading obtained | 1.524 |
| Tare | 0.761 |
| Surface tension, uncorrected | 0.763 |
| Correction | —7 divisions is equivalent to —11 mg. |
| Surface tension corrected | 0.752 |

$$\gamma = \frac{W \cdot g}{2L} = \frac{(0.752)\ (980)}{2 \times 5.2} = 70.7 \text{ dynes/centimeter}$$

(See Figures VII and VIII for surface tension vs. conc. by rings.)

**$NiSO_4 \cdot 7H_2O$ Solution**

| Conc. oz./gal. $NiSO_4 \cdot 7H_2O$ | Ring | Reading in Grams | Tare Upon | Correction |
|---|---|---|---|---|
| 28.1 | Pt | 1.561 | 0.759 | —3 |
| | Ni-Cr | 1.399 | 0.634 | —5 |
| | Cu | 1.346 | 0.535 | —5 |
| 21.08 | Pt | 1.558 | 0.742 | —4 |
| | Ni-Cr | 1.428 | 0.630 | —5 |
| 14.05 | Pt | 1.553 | 0.755 | —7 |
| | Ni-Cr | 1.470 | 0.637 | —8 |
| 7.03 | Pt | 1.568 | 0.758 | —6 |
| | Ni-Cr | 1.412 | 0.631 | —4 |
| 0.0 | Pt | 1.539 | 0.743 | 0 |
| | Ni-Cr | 1.490 | 0.613 | —3 |
| | Cu | 1.346 | 0.535 | —5 |

that it does not hamper the movements of the pan over which it stands. Due to the presence of the ring, support holding the ring which remains on the ring, a tare has to be obtained. In the case of the Du Nuoy tensiometer, the tare of the ring has been considered in the setting of the

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scale so that at a zero reading of the scale, the weight of the ring is automatically cancelled. Thus, the readings given on the other parts of the scale are given in terms of the difference between the surface tension plus the ring weight plus the liquid on the ring and the ring weight plus the liquid on the ring itself.

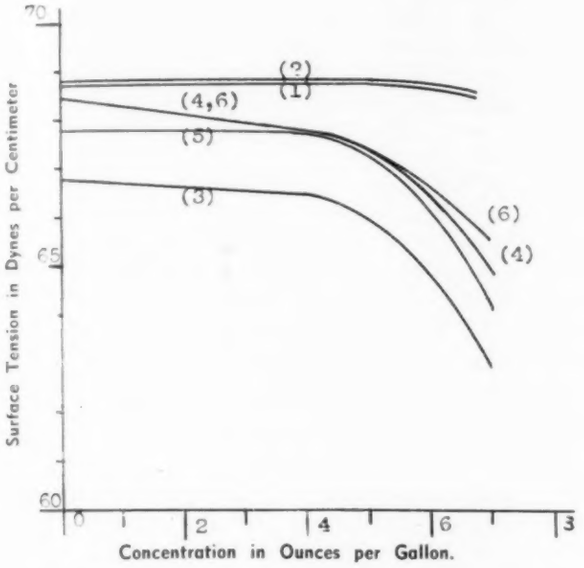


Fig. XV. Surface tension of $K_2Cu(CN)_3$ solution, as corrected, as a function of the concentration at 20° C. No free cyanide is present.

| Curve | Method |
|---|---|
| 1 | Capillary |
| 2 | Traube stalagmometer |
| 3 | Burette |
| 4 | Du Nuoy tensiometer |
| 5 | Balance with platinum ring |
| 6 | Balance with nichrome ring |

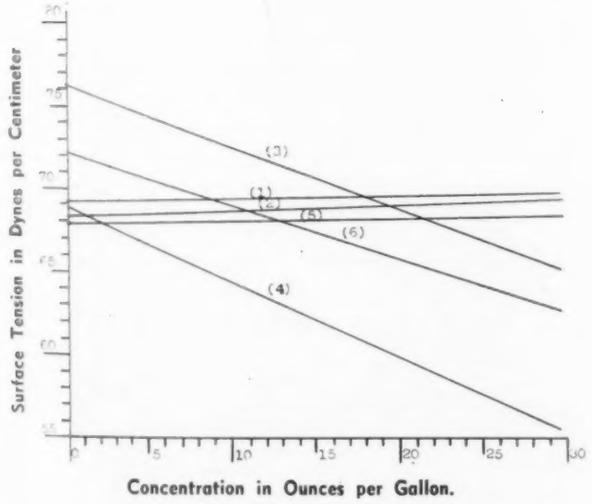


Fig. XVI. Surface tension of $NiSO_4 \cdot 7H_2O$ solution, as corrected, as a function of the concentration at 20° C.

| Curve | Method |
|---|---|
| 1 | Capillary |
| 2 | Traube stalagmometer |
| 3 | Burette |
| 4 | Du Nuoy tensiometer |
| 5 | Balance with platinum ring |
| 6 | Balance with nichrome ring |

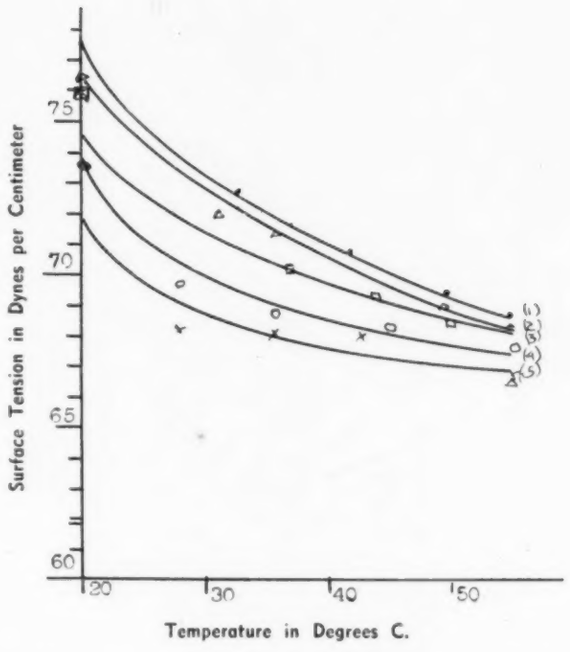


Fig. XVII. Surface tension of $K_2Cu(CN)_3$ solution as a function of temperature at various concentrations using the chemical balance with platinum ring (no free cyanide).

| Curve | Symbol | Concentration (oz./gal.) |
|---|---|---|
| 1 | • | 0 |
| 2 | △ | 5.66 |
| 3 | □ | 1.89 |
| 4 | o | 7.54 |
| 5 | x | 3.77 |

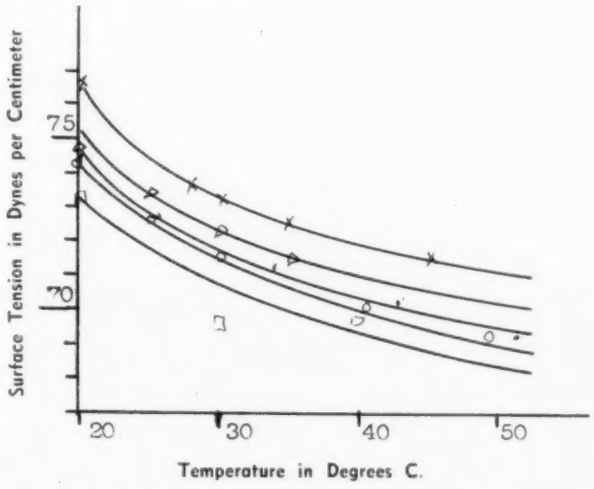


Fig. XVIII. Surface tension of $NiSO_4 \cdot 7H_2O$ solution, as a function of temperature at various concentrations using the chemical balance with the platinum ring.

| Curve | Symbol | Concentration (oz./gal.) |
|---|---|---|
| 1 | x | 21.08 |
| 2 | △ | 0.0 |
| 3 | • | 14.05 |
| 4 | o | 28.01 |
| 5 | □ | 7.08 |

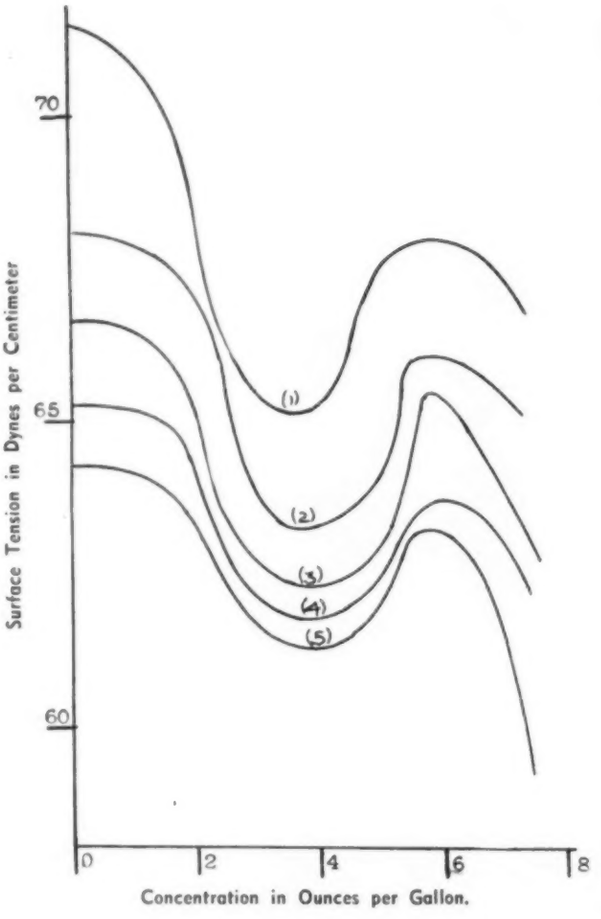


Fig. XIX. Surface tension as a function of concentration at various temperatures of $K_2Cu(CN)_3$ solution. From Fig. XVII.

| Curve | Temp. in Degrees C. |
|---|---|
| 1 | 20 |
| 2 | 25 |
| 3 | 30 |
| 4 | 35 |
| 5 | 40 |

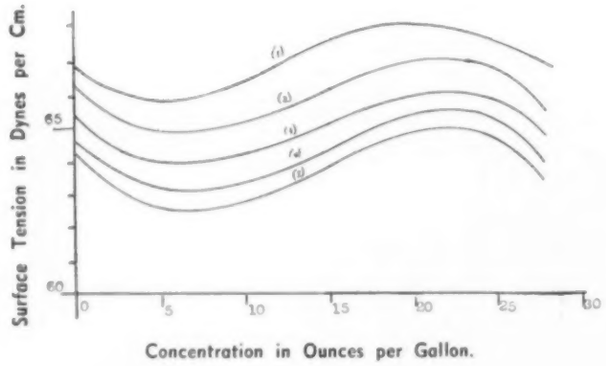


Fig. XX. Surface tension as a function of concentration at various temperatures of $NiSO_4 \cdot 7H_2O$ solution. From Fig. XVIII.

| Curve | Temp. in Degrees C. |
|---|---|
| 1 | 20 |
| 2 | 25 |
| 3 | 30 |
| 4 | 35 |
| 5 | 40 |

### *Conclusion*

The values of surface tensions by various methods as observed, as a function of concentration at 20° C. are shown in Figures VII and VIII. Very close correlation exists between those obtained by the capillary, burette and the Du Nuoy tensiometer. Du Nuoy values are generally accepted as correct. Using the constants for the stalagmometer that were supplied by the manufacturer, the surface tensions obtained were much above the values obtained by the Du Nuoy tensiometer as seen from Figures VII and VIII. The surface tension as obtained by the tensiometer was 68.5 dynes/cm. which was equivalent to a delivery of 42.12 drops. Using these values, rather than the ones supplied by the manufacturer, a good correlation with the Du Nuoy method is obtained for surface tensions by the stalagmometer using various solutions of different concentrations.

The values obtained by means of the chemical balance using both the platinum and the Nichrome rings are higher although they are closer to the values obtained by the tensiometer than the ones obtained by the stalagmometer. This variation is due to the ring, which manually constructed to a circumference of 5.2, is larger than supposed. The ring supplied with the tensiometer is measured by means of a machine and all connections are welded. In the case of the constructed ring, the connections are simply tied together and the circumference is measured by the eye. Another effect is the sharp points of our ring which will have a tendency to pierce the film. These joints have an effect of changing the effective circumference of the ring. This effect of the joint will be simply considered as an error in the measurement of the circumference of the ring. Thus, the curves are shifted down by applying a correction factor such that it will bring the midpoints of the copper cyanide curves (since these apparently are better curves) to the midpoint obtained by the Du Nuoy tensiometer. This same correction factor is applied to the curves of the nickel sulphate solution. These recalculated curves are shown in Figures XV and XVI. From the appearances a good correlation exists between all methods employed. The slight differences that do exist can be explained by a slight variation in technique.

At the outset three rings were to be used. They were platinum-iridium, Nichrome and copper wire. The values of the surface tensions by the rings as observed for the values of concentrations that were studied, are shown in the table.

**Surface Tension of $NiSO_4 \cdot 7H_2O$ Solution at 20° C.**

| Concentration in oz./gal. | Ring | Surface Tension in dynes/cm. |
|---|---|---|
| 28.10 | Pt-Ir | 74.8 |
| | Nichrome | 71.3 |
| | Cu | 75.6 |
| 0.00 | Pt-Ir | 74.7 |
| | Nichrome | 81.9 |
| | Cu | 75.6 |

From this table it is apparent that the surface tensions are functions of the type of surface of the ring. In the case of the Pt-Ir ring, there is no appreciable oxide coat formed, especially on ignition. In the other two cases, heavy oxide coats are formed. In the case of the Nichrome wire, the oxide coat is very dense so very little absorption takes place. On the other hand, the oxide on the copper ring is very loose so that it absorbs liquids. In the case of

the first two rings, ignition of the ring can be carried out at white heat for a sufficient period of time to cleanse the rings. On the other hand, the ignition of the copper wire must be slight so that it does not melt. Thus, a properly cleansed surface is not obtained. This is shown in the table above. In the case of the first two rings, a change in the surface tension is observed. In the case of the copper, the more concentrated solution has been absorbed and the ring has not been sufficiently cleaned by ignition so that there still remains in the oxide coat some of the solution. When it is placed into the water, the more concentrated solution will diffuse from the coat into the solution and for the moment remain in the liquid film about the wire. The amount of material that diffused into this film was sufficient so as to give an almost concentrated solution of the material. Thus, the appearance of the same surface tension in the concentrated solution and the water occurs. The ring on further ignition for the purpose of cleaning, melted.

During the use of the ring and the chemical balance, much trouble was encountered in the oscillation of the beam which at times caused the rupture of the surface even before the true value was reached. This can be prevented by the use of a magnetic damper on the balance. Chainomatic balances are more adaptable to this system of measurement than rider balances, as trouble in the latter case will be encountered due to the oscillations as the weights are shifted from one point to the other and also the time factor that will become appreciable.

According to the Eötvös-Ramsay-Shield equation, the surface tension as a function of time is given by the term

$$\gamma \frac{M}{d} = -K(T_c - T - 6)$$

K = Constant. $T_c$ = Absolute Temperature.
T = Temperature.

For a given liquid, the density is a function of the temperature. Thus, the function obtainable is a hyperbolic type. (See Figures XVII and XVIII.) The chemical balance with the platinum ring has been used to determine surface tension from here on. Correlation with the equation above will not be given, as the critical temperature is not known. In the experimental procedure, the surface tension is taken first. Immediately afterward, the temperature is taken by placing the solution in a bottle which is approximately the temperature of the solution. If enough solution is used, the difference in temperature between the glass and liquid will be of little immediate importance. If a sufficient amount of time has elapsed during a reading, the temperatures in the two cases will be different from each other and the effect will be appreciable. Care was taken so that time was not a factor.

The curves for the surface tensions as a function of the concentration apparently obey the Eötvös-Ramsay-Shields relation. The values when plotted as shown, on the other hand, do not show the striking similarity of the variation of surface with composition at a given temperature. The curves were replotted as shown in Figures XIX and XX using the values as corrected for the variation in the supposed and true length of the ring.

### *Discussion*

In general throughout the paper, a discussion either preceded or followed the method which was employed to

(*Concluded on page* 314)

**Observations of the Variation of Surface Tension with Temperature and Concentration Using the Chemical Balance with Pt Ring.**

$K_2Cu(CN)_3$ Solution

| Conc. in oz./gal. CuCN | Temperature in ° C. | Reading in gms. | Tare in gms. | Correction in Divisions |
|---|---|---|---|---|
| 7.54 | 55 | 1.478 | 0.761 | —4 |
| | 45 | 1.492 | 0.761 | —4 |
| | 35 | 1.496 | 0.761 | —4 |
| | 28 | 1.501 | 0.761 | —4 |
| | 20 | 1.524 | 0.761 | —7 |
| 5.66 | 55 | 1.455 | 0.744 | —3 |
| | 42 | 1.484 | 0.744 | —3 |
| | 36 | 1.505 | 0.744 | —3 |
| | 31 | 1.508 | 0.744 | —4 |
| | 20 | 1.548 | 0.744 | —3 |
| 3.77 | 55 | 1.474 | 0.761 | —3 |
| | 40 | 1.495 | 0.761 | —3 |
| | 35 | 1.499 | 0.761 | —3 |
| | 28 | 1.500 | 0.761 | —3 |
| | 20 | 1.560 | 0.761 | —2 |
| 1.89 | 65 | 1.458 | 0.744 | —3 |
| | 50 | 1.471 | 0.744 | —3 |
| | 44 | 1.487 | 0.744 | —3 |
| | 37 | 1.494 | 0.744 | —3 |
| | 20 | 1.548 | 0.744 | —2 |
| 0.00 | 70 | 1.451 | 0.743 | —3 |
| | 60 | 1.478 | 0.743 | —3 |
| | 50 | 1.486 | 0.743 | —3 |
| | 42 | 1.499 | 0.743 | —3 |
| | 20 | 1.539 | 0.743 | 0 |

$NiSO_4 \cdot 7H_2O$ Solution

| Conc. in oz./gal. $NiSO_4 \cdot 7H_2O$ | Temperature in ° C. | Reading in gms. | Tare in gms. | Correction in Divisions |
|---|---|---|---|---|
| 28.10 | 50 | 1.369 | 0.759 | —3 |
| | 45 | 1.470 | 0.759 | —3 |
| | 30 | 1.527 | 0.759 | —3 |
| | 25 | 1.530 | 0.759 | —2 |
| | 20 | 1.561 | 0.759 | —3 |
| 21.08 | 45 | 1.503 | 0.742 | —2 |
| | 35 | 1.514 | 0.742 | —3 |
| | 30 | 1.519 | 0.742 | —3 |
| | 28 | 1.523 | 0.742 | —3 |
| | 20 | 1.558 | 0.742 | —4 |
| 15.05 | 40 | 1.499 | 0.755 | —4 |
| | 35 | 1.517 | 0.755 | —2 |
| | 30 | 1.527 | 0.755 | —2 |
| | 25 | 1.534 | 0.755 | —2 |
| | 20 | 1.553 | 0.755 | —7 |
| 7.03 | 55 | 1.481 | 0.758 | —3 |
| | 45 | 1.488 | 0.758 | —3 |
| | 35 | 1.453 | 0.758 | —3 |
| | 28 | 1.463 | 0.758 | —3 |
| | 20 | 1.568 | 0.758 | —6 |
| 0.00 | 70 | 1.451 | 0.743 | —3 |
| | 60 | 1.478 | 0.743 | —3 |
| | 50 | 1.486 | 0.743 | —3 |
| | 42 | 1.499 | 0.743 | —3 |
| | 20 | 1.539 | 0.743 | 0 |

# The Effect of Copper on the Protective Power of Anodic Oxide Films on Cast Alloys of Aluminum and Copper†

By A. E. HOSTETTER, W. A. VAN WINKLE, AND H. H. KING

*Kansas State College, Manhattan, Kansas*

**Cast alloys of aluminum and copper ranging from pure aluminum to 13 per cent copper were tested by spraying with a salt solution and measuring the tensile strength in an effort to determine how the copper content affects the protection offered by the anodic oxide film. Both heat-treated and untreated samples were tested and in both cases samples were rendered more resistant to corrosion by anodic treatment in chromic acid.**

## *Introduction*

ALUMINUM, although an active metal, is resistant to corrosion because of the protective nature of oxide which forms on the surface. This film although protective is very thin, as can be judged by the high reflective power maintained by pure aluminum over long periods of exposure to the atmosphere.[1] The thickness, and the resulting protection of this coating, is often increased by using some artificial oxidation process, such as, anodic oxidation in chromic acid.[2]

When pure aluminum is thus anodized in chromic acid, the resulting oxide coating rapidly builds up resistance to the flow of current. Figure 1 shows the results of data taken during the anodic treatment of pure aluminum in ten per cent chromic acid. When metals are alloyed with the aluminum, however, the character of the film is quite different. The film is not generally so resistant to the flow of the current and the color is often dark, especially if silicon is in the alloy.

Since the character of the film is changed by the introduction of alloying elements, it is important to know whether the anodic film continues to offer protection against corrosion when such alloying elements are present. It would be of special interest to know the effect of copper since it is an important alloying element in most aluminum alloys. This investigation of the extent to which alloying elements in aluminum alloys change the protective power of anodic films was proposed by T. S. Fuller of the General Electric Company. It was decided to carry out such a test on cast aluminum alloys varying in composition from pure aluminum to 13 per cent copper. This upper limit was selected because cast aluminum alloys seldom run higher than this in copper content.

The problem of obtaining the special alloy castings needed was found to be a serious one, since the compositions desired were not generally used commercially, and their production, it was found, would require much special work for a commercial concern. It was therefore necessary for the authors to produce the desired alloy castings.

## *Method of Making Alloys Tested*

Melts were made up in an attempt to obtain alloys containing approximately 2, 5, 7, 10 and 13 per cent copper for this investigation. Analysis of the resulting alloys showed copper contents of 2.11, 4.89, 6.65, 11.09 and 13.19 per cent.

In order to avoid the introduction of other metals, the alloys were melted in a graphite crucible and poured with a graphite ladle. All samples of one composition were cast from the same melt. In order to avoid sudden freezing, the iron mold used was heated to 425° C. before introducing the molten metal. The temperatures of the mold and the molten metal were observed and carefully controlled during casting. The samples were cast in the form of flat tensile strength bars one-eighth inch in thickness and one inch wide at the constriction with the gate at the center of the constriction. Samples were allowed to cool in air

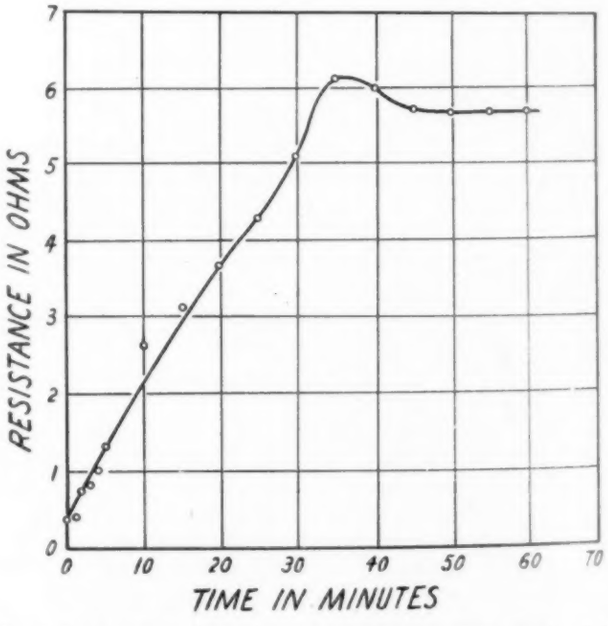


**Fig. 1. Resistance to flow of current during the anodic treatment of pure aluminum.**

† Portion of a thesis presented as a partial fulfillment of the requirements for the degree of Doctor of Philosophy at Kansas State College.

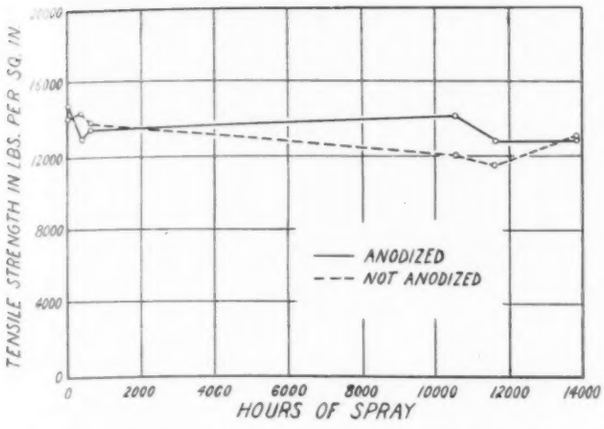


Fig. 2. Tensile strength of corroded samples of pure aluminum.

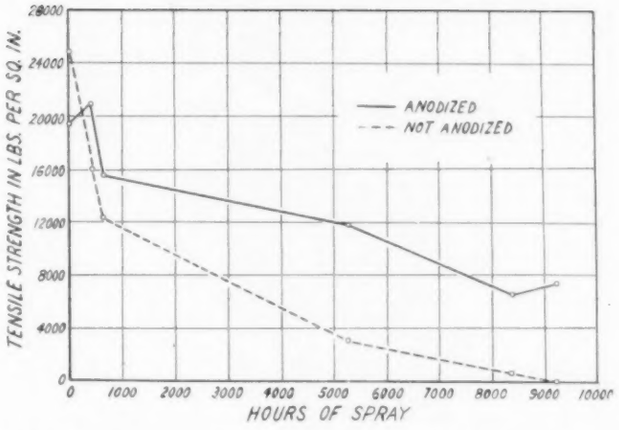


Fig. 4. Tensile strength of corroded samples containing 4.98 per cent copper.

after being removed from the mold. In order to ensure having sound castings for the test, they were carefully examined for cracks and any defects visible to eye. The X-ray fluoroscope was also used to reveal any internal cavities. The aluminum used in preparing these alloys was 99.5 per cent pure ingot metal obtained from the Aluminum Company of America.

A set of 36 samples of each composition were carefully selected for the test. Half of the samples were anodized in ten per cent chromic acid for an hour as described in the United States Navy Department Aeronautics Bureau SR 19a 1932.

### *Testing*

The tensile strengths of three anodized and three unanodized samples of each composition were obtained and the remainder were placed in a test box in which they were subjected to a fine spray of ten per cent NaCl in water.

The spray was produced by two glass asperator nozzles using air under a pressure of 30 pounds per square inch. Before reaching the nozzles, the air was cleaned and humidified by being passed through water and then through wet excelsior. The salt solution was drawn from the box and discarded after passing over the samples once. The spray box consisted of glass cemented into a frame work of angle iron. A record was kept of the spraying time and at various intervals three samples from each group were removed and their average tensile strength (in pounds per square inch) determined. At different times during the test it became necessary to remove the excessive corrosion products from the samples in order to allow the salt spray to get between the samples.

### *Results*

The number of hours the various samples were subjected to the salt spray and their respective tensile strengths after such treatment are shown in Figures 2, 3, 4, 5, 6 and 7. It will be observed that the pure aluminum reduced very little in tensile strength during 14,000 hours of exposure to the spray. As the copper content of the samples is increased, the rate of corrosion is also increased. Samples containing 13.19 per cent copper were destroyed after being sprayed about 5,000 hours.

As previously indicated, the purpose of this work is to determine the relation of copper content and the resistance to corrosion offered by the anodic oxide film. In order to obtain a comparison between the anodized and the unanodized samples of a given composition and thus have a

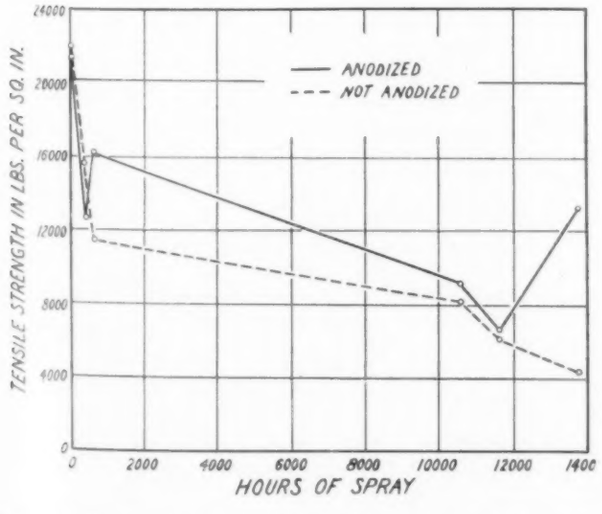


Fig. 3. Tensile strength of corroded samples containing 2.11 per cent copper.

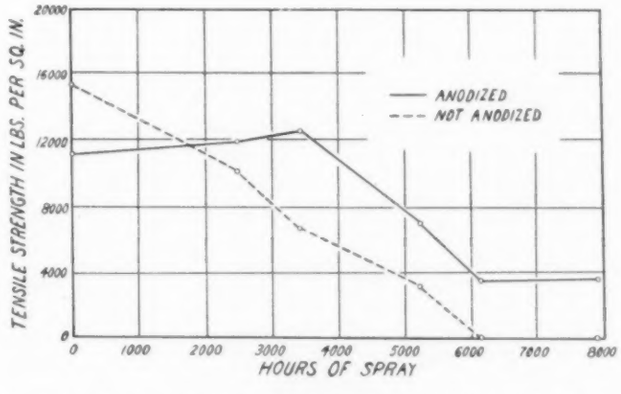


Fig. 5. Tensile strength of corroded samples containing 6.65 per cent copper.

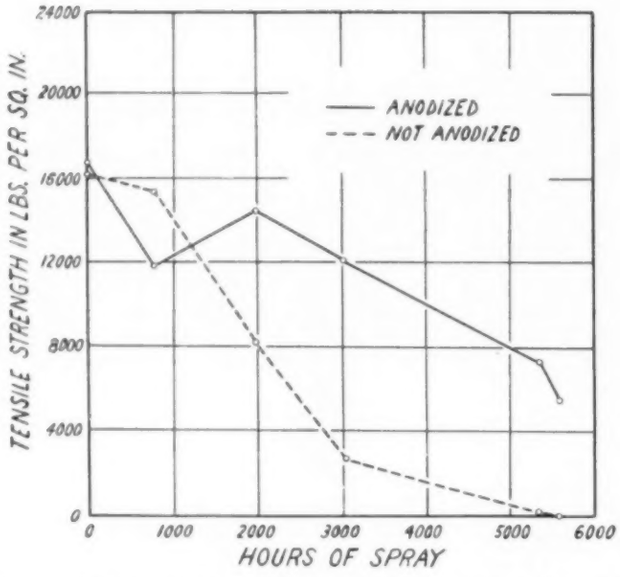


Fig. 6. Tensile strength of corroded samples containing 11.09 per cent copper.

measure of the effectiveness of the film in preventing corrosion, the areas under each of the curves in Figures 2, 3, 4, 5, 6 and 7 were calculated. The areas are in terms of pound hours or a tensile strength of one pound per square inch maintained through one hour. By comparing these areas, one has a measure of the relative resistance to corrosion of the various alloys.

The per cent of additional strength maintained due to corrosion resistance as a result of anodic treatment can be calculated as follows:

$$\frac{A-B}{B} \times 100 = \text{per cent}$$

Where A = area under curve of anodized samples
B = area under curve of unanodized samples

This value was calculated for each alloy and plotted against the per cent of copper in the alloys, Figure 8.

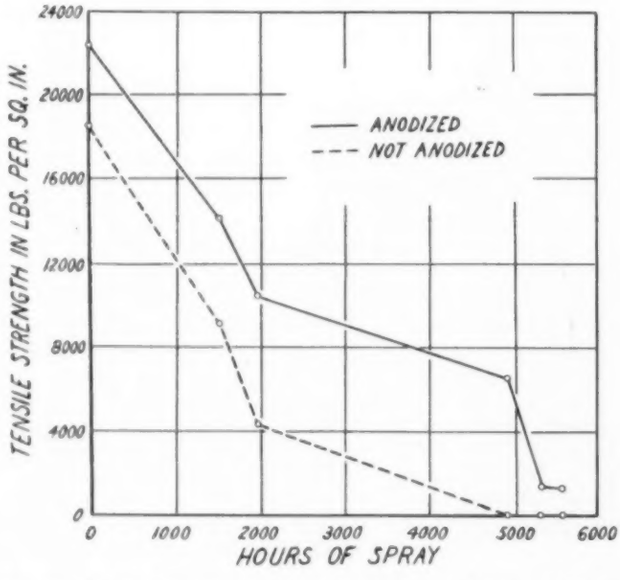


Fig. 7. Tensile strength of corroded samples containing 13.19 per cent copper.

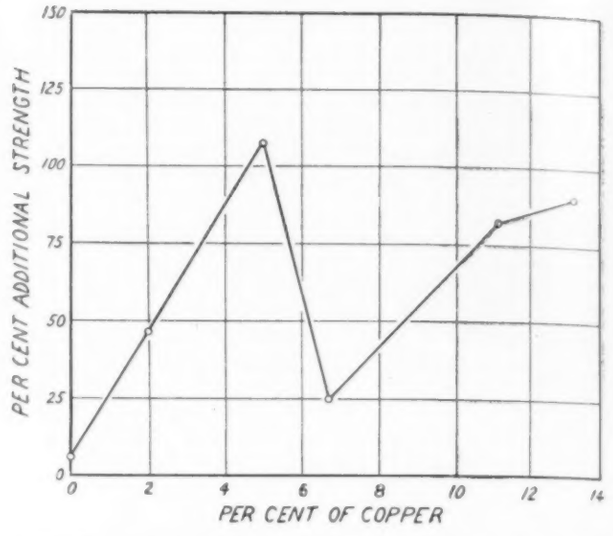


Fig. 8. Per cent of additional strength maintained due to corrosion resistance resulting from anodic treatment.

From Figure 8 one might draw the conclusion that anodic oxide films are not very effective in preventing corrosion of pure aluminum, but in the case of the pure aluminum, after 14,000 hours, neither the anodized nor the unanodized samples had suffered sufficient corrosion to change their tensile strength very much.

The difference between the loss of strength of the anodized and the unanodized aluminum is, therefore, not so marked as in the case of samples containing more copper where some of the unanodized samples suffered almost total destruction.

It has been suggested by Joyce[6] that anodic treatment is not applicable to aluminum alloys containing copper in excess of five per cent. The results of this investigation indicate that there is a drop in the effectiveness of the film on alloys containing more than five per cent copper, but even at 11.09 per cent and 13.19 per cent, the anodic film offers considerable protection.

### *Equilibrium Relations of Copper and Aluminum*

The equilibrium relations of copper and aluminum are of importance in interpreting the results of such a study. From the equilibrium diagram[3, 4] it is possible to calculate the relative amounts of the various constituents present when equilibrium exists. In actual practice, however, it is found that equilibrium is not always attained especially when alloys are cooled rapidly. For example, when an alloy containing five per cent copper is cooled quickly from the molten condition to room temperature, the crystals formed are not homogeneous and this causes a condition known as coring (cored crystals)[5]. This coring is due to the fact that the first portion to freeze out contains only a limited amount of copper as determined by the maximum solubility of copper at that temperature. As the temperature lowers, the solubility gradually increases reaching 5.65 per cent copper at 550° C. Thus if cooling is rapid and equilibrium is not maintained, the resulting crystals will have a center which is lean in copper and an outer portion which is rich in copper.

This irregular distribution of copper presents a condition of great significance in regard to corrosion. With the center

Fig. 9. Corroded sample of pure aluminum.

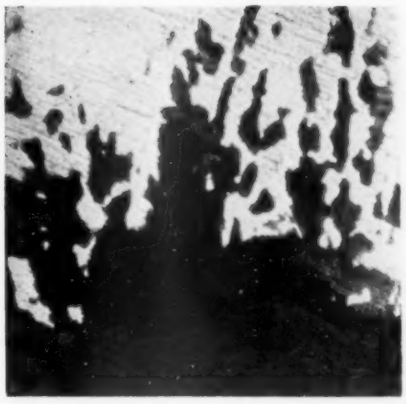

Fig. 10. Corroded sample containing 2.11% copper.

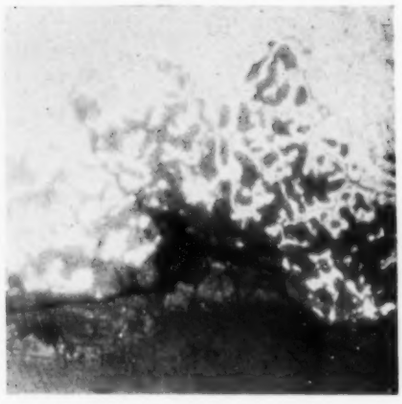

Fig. 11. Corroded sample containing 4.89% copper.

Photomicrographs of transverse sections of corroded samples (Figures 9-14). The light portion on each is metal and the dark is mounting plastic or voids in the metal due to corrosion. Magnification 100x, unetched. The lack of sharp line division between the light and dark areas is due to rather gradual slope from the metal surface to the bottom of pits caused by corrosion.

of the crystal consisting of nearly pure aluminum (an active metal), there is a possibility of electrochemical cell action being set up between the center and the outer portion of each crystal. The aluminum-rich center would serve as an anode and the copper-rich outer portion as a cathode. Thus, there should be a tendency for the center portion of such crystals to go into solution first.

In order to study the progress of corrosion, microscopic examinations were made from time to time, and photomicrographs were taken of typical specimens. The corroded edges of the samples were preserved by embedding them in a plastic and polishing on a plane perpendicular to the corroded surface. It will be observed in Figures 11 and 12 that there is a very marked tendency for corrosion to take place at the grain boundaries and in the center of the crystals causing a sort of honey-comb structure. This type of corrosion is taken as an indication of cored crystals as described earlier.

In the cases of samples containing 11.09 and 13.19 per cent copper (Figures 13 and 14), the corrosion seemed to take place only at the grain boundaries. The authors have no satisfactory explanation for the lack of coring in these ranges.

### *Heat-Treated Samples*

When the samples described above were cast, additional 36 samples were cast from each melt. These samples were heat-treated by holding them at a temperature of about 530° C for one hour and then quenching in water at 98° C, after which the samples were aged at 110° C for 24 hours. One half of these samples were anodized in chromic acid, while the other half received no anodic treatment. All samples were then subjected to a spray of sodium chloride solution as described before.

A comparison of the corrosion resistance of the anodized and the unanodized samples in the heat-treated series also showed an increase in corrosion resistance as a result of anodic treatment. In comparing the corrosion resistance of the anodized samples of this series with that of the anodized samples of the un-treated series, it was observed that alloys containing 2.11 and 4.89 per cent copper were rendered somewhat more resistant to corrosion as a result of the heat-treatment while the pure aluminum and the alloys containing 11.09 and 13.19 per cent copper were affected very little by heat-treatment and the alloys containing 6.65 per cent copper seemed to be more readily

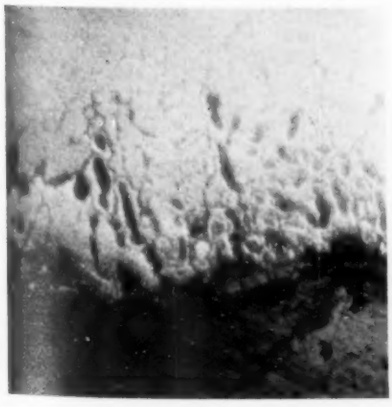

Fig. 12. Corroded sample containing 6.65% copper.

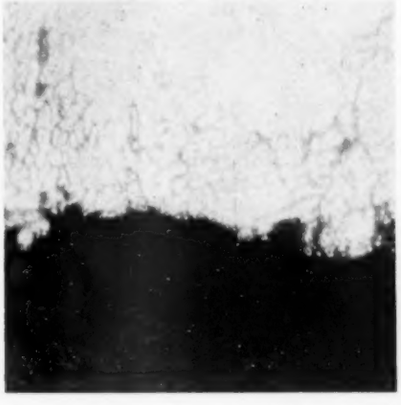

Fig. 13. Corroded sample containing 11.09% copper.

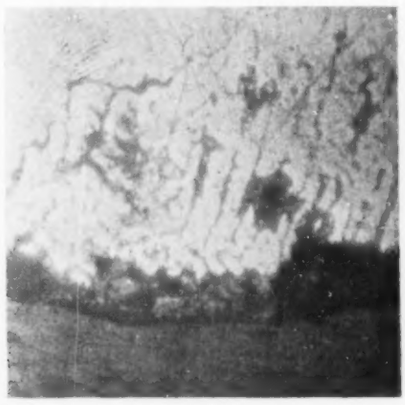

Fig. 14. Corroded sample containing 13.19% copper.

corroded as a result of the heat-treatment.

There are several factors which must be considered in comparing the corrosion resistance of the anodized heat-treated samples with that of the samples which were anodized, but not heat-treated, such as, a possible difference in the nature of the anodic films on the heat-treated and the unheat-treated samples, the increase in tensile strength resulting from heat-treatment, and the changes in the character of the main body of the metal which might change the corrosion resistance of the sample.

Microscopic observations of the various corroded specimens of the heat-treated series revealed less evidence of a cored structure than was noted in those unheat-treated alloys with a copper content of 4.89 and 6.65 per cent. This would be expected since heat treatment permits diffusion and this in turn results in a more homogeneous condition in the metal. The evidence of cored structure, in the case of the heat-treated series, would indicate that the heat-treatment used was not sufficient to permit the establishment of equilibrium. For this reason only the data on the un-treated series have been presented in this paper.

### *Conclusions*

The results of this investigation indicate that cast aluminum copper alloys, which had not been heat-treated, ranging from pure aluminum to 13 per cent copper are rendered more resistant to corosion in salt spray by anodic treatment in chromic acid, and that the rate of corrosion increases with copper content.


### *Acknowledgments*

The authors wish to express appreciation for the help of the following persons: T. S. Fuller of the General Electric Company in suggesting the problem; S. Tour of the Lucius Pitkin, Inc., New York, for his many helpful suggestions; Prof. G. A. Sellers and Dr. M. J. Stutzman of the Kansas State College for their assistance in the metallographic study.


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## Surface Tension Measurements

(*Concluded from page* 309)

determine surface tension. The same is true for variables with the exception of temperature. Therefore a discussion of the data obtained on this variable will not be amiss at this point. In Figures XVII and XVIII, the surface tension is obtained by the analytical balance ring method. Both show a definite tendency to decrease surface tension as temperature increases. It will be noted that there are some peculiar results in both of these figures. For instance in the case of Figure XVII, curve 2 is above curve 3 in spite of the greater concentration represented by curve 2. This is also true in respect to curves 4 and 5. In the case of Figure XVIII, curve 1 is above curves 2, 3, and 5. Also curves 3 and 4 are out of line with respect to curve 5.

The cause of this is not known. It is possible that the data are incorrect. However, the authors feel that the general contour of the curves is correct. Perhaps at a later date these data can be rechecked by the authors or some others who might be interested. It might be that the evaporation of the solution may interfere with the determination of surface tension by the ring method. If so, the capillary or oil submerged drop method should be used to obtain such data.

On the basis of Figures XVII and XVIII, to show the variation of surface tension with concentration, Figures XIX and XX have been drawn. These show the variation of surface tension with concentration at various temperatures. Undoubtedly, the first dip on both curves should not be present based on our previous work. No explanation will be given for this behavior.

The Du Nuoy tensiometer method can be taken as giving correct measurements. The ordinary titration burette can be used to obtain accurate data provided the tip is not damaged and the velocity of discharge is about fifteen drops per minute and the volume used for any given run is not greater than two ccs. The capillary can be used provided it is calibrated for variations in the diameter of the capillary at different heights. The analytical balance ring method can be used provided the rings are calibrated directly or indirectly with a Du Nuoy tensiometer. The stalagmometer values per se are generally high, but may be corrected as shown in the paper.


**Plating and Finishing Guidebook**
**1941 Edition**

**EDITED BY DR. WALTER R. MEYER**

***The composite effort of 25 experts in the plating and finishing industry. New Sections—Complete Revision. Your subscription to Metal Finishing will bring you, free, this authoritative and modern book.***

PLATING AND FINISHING
POLISHING — BUFFING
CLEANING — PICKLING
HOT DIP FINISHES

# SHOP PROBLEMS

## Nickel Plating with Insoluble Anodes

*Q.* Due to the extreme shortage of nickel, we are faced with the problem of nickel plating, using inert anodes. Will you kindly let us have your advice on the factors that arise with the use of inert anodes in place of nickel anodes.

*A.* The determining factor in the use of insoluble anodes for nickel plating is the presence or absence of chlorides.

If chlorides are present, which is the case with solutions that have been used with nickel anodes previously, practically every metal, including platinum, will be attacked to some extent by the chlorine which is evolved at the anode during electrolysis. An alloy of 39 parts by weight of lead and 61 parts of silver has been stated by Fink and Pan to resist chlorides, due to the formation of a film of silver chloride and lead peroxide but the cost is almost prohibitive.

Carbon is usually the only practicable anode material in chloride solutions. However both graphite and amorphous carbon, such as gas carbon, disintegrate in acid solutions, particularly those containing sulfuric acid. In view of the fact that graphite is attacked to a lesser extent by chlorine, this material would be more desirable. Due to the disintegration of the anode, fine particles of carbon are dispersed in the solution with resultant rough nickel deposits. The anodes should therefore be bagged, preferably with a filter bag which has a layer of filter paper between two sheets of cloth.

The life of carbon anodes will be increased if the anode current density is kept low, so that a minimum of oxygen is evolved. Mantell also states that in salt electrolysis the life of a graphite anode is increased by impregnating it with a cobalt solution which reduces the anodic voltage.

If a new solution is made up using only single nickel salts and boric acid, without chlorides, lead alloys are suitable as anodes especially those containing a small amount of silver. Lead alloys containing 1-2% silver and 2.5-7.5% silver have been patented by Tainton, and Suchy and Messner respectively, and have been used successfully for zinc plating from the acid sulfate solution. Fink and Kolodney in their investigation of electrolytic manganese production found that the presence of cobalt (0.3-0.4%) in the lead anode or in the solution, inhibits the solution of the anode.

High silicon anodes have been patented by Fink for copper electrowinning from the acid sulfate solution, the chloride content of the solution being below 0.5 gram per liter. The "COSIL" anode contained silicon, manganese, chromium and cobalt while his "CHILEX" anode contained copper, silicon, lead and small amounts of tin.

When insoluble anodes are used, the pH of the solution has a tendency to drop rather rapidly, even when sufficient boric acid is present as a buffer. This phenomenon is due to the deposition of nickel and liberation of oxygen, according to the following simplified equation:

$$2NiSO_4 + 2H_2O = 2Ni + 2H_2SO_4 + O_2$$

The sulfuric acid which is formed during electrolysis must be neutralized in order that the pH might not drop below the practical plating range.

Theoretically, and practically within certain limits, any alkali could be used for this purpose but the following factors should be considered:

Sodium hydroxide will result in an accumulation of sodium sulfate which will lower the limiting current density at which burning of the deposit occurs.

Ammonium hydroxide will result in the formation of double nickel salts, the solubility of which is quite low and if a nickel content of more than 3 oz./gal. is maintained, there will be a tendency to precipitate the crystals of nickel ammonium sulfate in cold weather, especially on the anodes.

Calcium or barium hydroxide have the advantage of not only neutralizing the acid but removing the sulfate as insoluble calcium or barium sulfate. However calcium sulfate is somewhat soluble in slightly acid solutions and barium sulfate is very difficult to filter.

Basic nickel salts are to be preferred as additions and have been used for years for this purpose. The advantage of these materials is that they replenish the nickel content while at the same time they reduce the acidity and there is no accumulation of sulfate, as would be the case where single nickel salts were used to replenish the metal content.

The basic nickel salt, either nickel carbonate or nickel hydroxide is never added directly to the plating solution, because the suspended particles will result in rough and porous deposits. It may be added, as a slurry, to the filter cake on a filter press and the solution pumped through the cake. The precipitate tends to clog the filter cloth however and the flow is decreased appreciably.

The preferable procedure is to remove a portion of the plating solution into a small storage tank. The nickel salt is then added directly to this solution and stirred, if possible keeping the solution hot by means of a lead heating coil or a lead sheathed electric immersion heater.

The mud is allowed to settle and the clear supernatant solution is decanted or filtered back into the plating tank. The mud which is excess nickel carbonate or hydroxide need not be removed from the bottom of the storage tank, additional portions of plating solution being added to it as required and more nickel salt added as required to keep an excess present in the storage tank.

—G. B. H., Jr.

## Silver Brightener

*Q.* We would appreciate your mentioning a method of brightening silver plate, just what color should the work be when it comes out of the solution after adding the brightener, and is there any method of determining whether the correct amount of brightener has been added.

*A.* The formula recommended in the Plating & Finishing Guidebook is still the best one and will give excellent results if properly used. Unfortunately, there is no way of testing the solution to determine how much brightener it contains or how much should be added. The latter can be judged only from experience with your own production and from the appearance of the plated work, which should look semi-glossy with a light, bluish sheen, and neither matte nor milky white. It should "polish" merely by rubbing with the finger. If it does not have this appearance, brightener should be added in amounts equivalent to about ⅛ fluid oz./gal. until no further improvement is obtained. Do not add it in excess. Sometimes, increasing the current density helps.

It is best to add brightener frequently in small amounts rather than less often in larger amounts. Additions at the beginning and middle of the day usually are sufficient and satisfactory. The thickness of the deposit will not be affected by the addition of the brightener, provided the current used and the time of plating are not deliberately changed.

—N. E. P.

## Acid Test for Gold Plated Article

*Q.* In my work I must deposit a gold plate that will withstand an acid test. Will you tell me what is used in the acid test and how to apply it to gold plated articles.

*A.* Apply a drop of concentrated nitric acid to the cleaned dry surface of the article to be tested.

The acid will show no gassing action, or discoloration, if the gold deposit is completely protecting the base metal. There is no rule to go by as to the length of time the deposit will withstand the action of the acid before a break through occurs.

A deposit of gold as thin as 0.000008″ has been stated, however, to withstand the action of nitric acid for a few seconds, (the gold being deposited directly on brass).

—G. B. H., Jr.

## Color Control in Gold Plating

*Q.* I am now using a gold solution composed as follows:

| | |
|---|---|
| Potassium cyanide | 4 oz. |
| Sodium phosphate | 4 " |
| Potassium ferrocyanide | 1 " |
| Gold | 10 dwt. |
| Water | 3 gal. |

I dissolve the gold in ribbon form in aqua regia made of 4 oz. muriatic acid and 2 oz. of nitric acid, and then precipitate the gold with about 1½ pts. of ammonia. After washing six or seven times, I find the ammonia completely gone. After dissolving the potassium cyanide, sodium phosphate and potassium ferrocyanide in 3 gal. of water, I then add the gold, free from ammonia, to this bath, which immediately dissolves the gold. I use stainless steel anodes on both sides of the bath.

My problem is how to deposit gold in dark shades. I obtain a fine gold but it is too light. The addition of potassium ferrocyanide did not produce a darker or deeper color. Can you suggest a method of obtaining the dark shade of 24K gold. I would also like to know how to obtain a beautiful chocolate brown background after gold plating.

*A.* The color of a light deposit of gold is influenced by the color of the metal upon which it is deposited.

If a 14K color is wanted, then the gold should be plated over a bronze plate or on bronze metal. If 18K is desired, plate on brass. A high brass will impart a greenish color to a light gold deposit.

It is not advisable to control color only by composition of the solution. Variables that are difficult to control such as current density, effect of chemicals not readily tested for, and undesirable impurities, will have large influences on the color. Unless some special shade far from a 24K is desired, then, it would be preferable to operate the 24K solution as you are now doing and obtain some variation in shade by the base metal color.

For karat gold solutions consult pages 43 and 44 of the 1941 Edition of the Plating & Finishing Guidebook. A red gold formula is:

| | |
|---|---|
| Potassium gold cyanide | 1 oz. |
| Potassium cyanide | 1 " |
| Copper cyanide | 6 grains |
| Water to make | 1 gal. |

Voltage 2 to 4. Temperature 140° F.

For a chocolate brown background smut try a deposit from a bronze solution low in free cyanide. —G. B. H., Jr.

## Finish on Steel Buckle

*Q.* Having benefited by your previous advice (June 1938) I venture to send another query for your consideration.

It is desired to duplicate the finish on the samples enclosed both as regards basis metal lustre and color of bronze. Questions, the answers to which would be of particular use to me are as follows:—

1. Is the brilliant lustre of the buckle due to case hardening followed by burnishing?

2. Is the brilliance of the buckle obtained by simple shot and soap burnishing?

3. Is there a simple shop test to determine whether a sample is case hardened or not?

4. From what solution can the brown coloration be obtained? (N.B. The film is soluble in hydrochloric acid.)

Awaiting the favour of your reply.

*A.* Taking up your questions in order:

1. The high lustre has been obtained by hardening, either case hardening or another method.

2. After hardening, roll in emery and oil, or with some similar abrasive. Follow with steel ball rolling using soap and water.

3. A simple test for case hardened surface: It will not be scratched when abraded with a file.

4. The color of this buckle appears to have been obtained by heat treating, that is, by heating to a color just short of blue. —G. B. H., Jr.

## Hot Barrel Brass Solution

*Q.* I am in search of a hot barrel brass plating solution which will give a yellowish-green deposit for flash plating upon tubbed copper pieces. We usually flash plate for about 2 minutes in an inclined rotating basket; pieces are about the size of a dime.

*A.* It is not clear whether it is more important for you to obtain a deposit of a certain color, or to obtain rapid plating. Generally, the color is the desired factor. In such a case, it would be more desirable to operate a brass solution warm, rather than hot, and use a formula such as given on page 32 of the 1941 Edition of "Plating & Finishing Guidebook", as a start:

| | |
|---|---|
| Copper cyanide | 4 oz. |
| Zinc cyanide | 1¼ " |
| Sodium cyanide | 6½ " |
| to start, increase to | 7½ " |
| Sodium carbonate | 4 " |
| Water to make | 1 gal. |

Operate at 100° F.

The use of a hot solution presents the disadvantage that the cyanide is more rapidly decomposed to carbonate. It also deteriorates the barrel itself faster. To obtain the shade of brass you desire, some experimenting is necessary, but all conditions should be controlled during these tests so that you know where you are. The current density, temperature of the solution and chemical composition must be known. The use of less copper and free cyanide than given in the above formula will tend to produce a greener deposit. A higher pH, obtained by the addition of ammonia, will also have a tendency to produce a deposit of a greener shade. A high speed brass solution is on the market which may be applicable to your case.

—G. B. H., Jr.

## Fumes from Sodium Cyanide

Q. I have a silver replating outfit which I intend to use in the cellar. It has been called to my attention that the fumes from the silver cyanide plating bath are very injurious, and if a sufficient amount is inhaled, it is fatal.

I have been using a sodium cyanide solution for the past 15 years for cleaning silverware without any disagreeable results.

A. There should be no fumes from a *correctly operated* silver solution. Under proper conditions, there is no gassing at either the anode or cathode.

There is a slight odor from any cyanide solution even when not under electrolysis. Some people are susceptible to even this slight odor. In such cases, the fumes from cyanide solutions that do gas, such as cyanide copper, can cause attack of the membranes of the throat and nostrils with possible attendant hemorrhages, but such action would not necessarily be fatal.

The U. S. Bureau of Mines has a figure of 100 parts per million of hydrocyanic acid gas allowed maximum in the air in which a man may safely go without a gas mask. A method for measuring such concentrations was described in the magazine Journal of Industrial Hygiene, Vol. 5, page 97 (1923) by Katz and Longfellow. Your State Dept. of Health will gladly cooperate with you in determining the extent of hazard present.

## Copper Plating as a Stop-Off in Carburizing

*Q.* We are copper plating SAE 4620 and SAE 3115 steels, and are carburizing them in the furnace at 1700° F. for 7 hours. About 1 hr. copper plate is deposited from a Rochelle salt solution.

Will you kindly give us your advice on this problem.

*A.* In general, the reason the steel is being hardened through the copper is that the copper deposit is porous, or too thin for the carburizing action desired for the rest of the article. Actually, the longer the carburizing time, the heavier the copper deposit required to completely stop-off the base metal from the action of the carburizing gases. Even a coating of 0.001" is not completely impervious to the carburizing gases, although this thickness is usually entirely satisfactory. Due to the long carburizing time, you probably require a thickness in excess of 0.001", and we suggest that you deliberately apply thicknesses of the order of 0.001" and heavier.

The porosity of the copper deposit is influenced by the composition of the solution and it is suggested you have the solution checked by analysis. The condition of the base metal on which the copper is deposited will also affect the porosity. The long hydrochloric acid pickle, which you are using, will tend to roughen the metal excessively and thus work against obtaining a deposit with least porosity.

The proper cleaning procedure cannot be given without examining your set-up and some of the work. In general, it is desirable to clean scaled work thoroughly before acid pickling, so that the acid will work uniformly. Thus after your de-oiling, let the work be alkaline cleaned before pickling.

Methods for testing the thickness and porosity of electrodeposited coatings are given on pages 117-125 of the 1941 Edition of the "Plating & Finishing Guidebook". It is suggested you test the copper coatings in order to compare their porosity, and thickness, with the results obtained in the hardening.

**Fundamentals of Science**
**This feature will be continued in the July issue.**

# ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—FINISHING—RUST PROOFING—LACQUERING

### Bright Zinc Plating

*U. S. Pat.* 2,233,500. L. R. Westbrook, assignor, by mesne assignments, to E. I. duPont de Nemours & Co., March 4, 1941. A cyanide zinc bath containing an oxyheterocyclic compound such as coumarin, furfural, furfuran, pyronine, paraldol, ethyl furoate, tetrahydrofurfuryl alcohol, hydrofurfuramide, methyl furoate, furfuralamine, tetrahydrofurfuralamine, dihydroxymethylxanthene, fluorescein, morpholine ethanol, phenyl morpholine hydrochloride, butyl morpholine hydrochloride, diphenylene oxide, cyclohexene oxide, glycol formal, coumalic acid and furfuramide, and a metal of the group consisting of molybdenum, chromium, cobalt, nickel, manganese, iron, titanium, rhenium, aluminum and tungsten. A series of 93 examples are given in this patent.

### Etching Nickel

*U. S. Pat.* 2,233,546. C. E. Meulendyke, March 4, 1941. The use of solutions containing cupric chloride alone and with ferric chloride to etch nickel alloys and nickel coatings. A suitable solution for etching alone is 40% by weight of cupric chloride in ethanol or water. This attacks nickel much more readily than it does copper. After etching through a nickel coating into a copper base there is suggested the use of a 40% solution containing ⅔ ferric chloride and ⅓ cupric chloride to prevent undercutting of the nickel layer.

### Cleaning Brass

*U. S. Pat.* 2,235,828. C. A. Vincent-Daviss and H. L. Maxwell, assignors to E. I. duPont de Nemours & Co., March 25, 1941. The cleaning and prevention of season cracking of brass by washing in a solution of alkali metal cyanide, washing to remove cyanide from the surface and depositing on the washed brass surface an organic sulfur compound selected from the groups consisting of mercapto aryl thiazoles, hydrocarbon mercaptans and the corresponding disulfides and drying to leave a film of said organic sulfur compound on said brass surface.

*Example:* Wash in 0.1—5 oz./gal. sodium cyanide solution. Rinse and apply a solution containing 0.01—1% by weight of mercapto benzo thiazole.

### Determining Tin Coating Weight

*U. S. Patent* 2,206,026 J. S. Buser. A method of determining the weight of coating on tinplate in which the tin is stripped anodically in an electrolyte containing hydrochloric acid, potassium iodide and an iodine liberating agent of the group consisting of potassium iodate, potassium permanganate and potassium dichromate. The correction factor of the electrolytic cell is first determined by passing a predetermined constant electric current through said cell for a predetermined time and thereafter subjecting each specimen to electrolysis under the same constant current conditions for the same period of time in the same cell. The excess of iodine liberated is determined by titration with standard thiosulfate solution and the tin content is corrected by said correction factor.

*Example:*

A glass beaker with 200 cc. of hydrochloric acid solution containing 1 part acid to 20 parts water plus 15 cc. of standard potassium iodate solution, each cc. of which is equivalent to 0.007 gram of tin, is used as the electrolyte. The standard potassium iodate solution contains also 0.04 gram per cc. of potassium iodide. Carbon cathodes 3 x 1 x 3/16 inches are used, spaced 1.5 inches apart. A specimen 2 inches square is used, being placed between the cathodes. A current of 1 ampere is passed through for 3 minutes, this being sufficient to remove all the tin from a specimen having 1.5 lbs. of tin per base box.

### Process and Compound for Polishing Plastics

*U. S. Patent* 2,062,671, *Dec.* 1, 1936; *Reissue No.* 21,432, *Apr.* 23, 1940. Joseph Lupo, Jr. A process of finishing and polishing plastic articles which consists in abrading same with an abrasive material consisting of granular fibrous base, impregnated by and coated with a vehicle including degras, petrolatum, and a mineral cutting oil and a powdered abrasive adhesively bonded thereto by the vehicle.

*Example:*

| | |
|---|---|
| Wood fragments | 16 parts by wt. |
| Light lubricating mineral oil | 2 " |
| Powdered pumice | 4 " |

*Example:*

| | |
|---|---|
| Sawdust | 45 parts by wt. |
| Vehicle coated on the sawdust | 18 " |

(Vehicle consists of 60 parts degras, 40 parts petrolatum, 5 parts red oil, 20 parts mineral cutting oil, 15 parts precipitated chalk and 16 parts of ground tripoli by weight.)

*Example:*

| | |
|---|---|
| Shoe pegs | 20 parts by wt. |
| Cream coated on the shoe pegs | 0.25 " |

(Cream consists of 6 parts yellow carnauba wax, 6 parts stearic acid, 21 parts spermaceti wax, 21 parts white beeswax, 4 parts oil of paraffin, 64 parts turpentine and 16 parts of abrasive such as tripoli, carborundum, infusorial earth, etc., all by weight.)

### Buffing Wheel

*U. S. Pat.* 2,236,444. C. J. Peterson and A. H. Peterson, March 25, 1941. A self cooling buffing wheel.

### Hot Dipping

*U. S. Pat.* 2,236,840. J. J. Scott and W. P. Baria, April 1, 1941. A molten bath of the following composition:

| | |
|---|---|
| Thallium | 10% |
| Tin | 20 " |
| Antimony | 5 " |
| Copper | 3 " |
| Lead | 62 " |

The coating is very adherent, it is claimed. The alloy is prepared by first heating the thallium to fluidity (about 1250°F.). The copper is melted and added with agitation. The other materials are then added to the fused mixture, as pigs.

### Corrosion Inhibitor

*U. S. Pat.* 2,238,651. F. G. Keenen, assignor to E. I. duPont de Nemours & Co., April 15, 1941. Method of inhibiting the corrosive effect of ammoniacal ammonium nitrate solution upon ferrous metals which comprises addition of small quantities of thiourea.

### Buffing Wheel

*U. S. Pat.* 2,239,140. H. J. Barton and R. H. Barton, assignors of thirty one-one hundredths to F. L. Szafranski and one tenth to C. E. Wisner, April 22, 1941. An automatically expandible polishing and buffing wheel.

### Protection of Iron, Steel and Zinc

*U. S. Patent* 2,206,064 J. S. Thompson and H. F. Bristol, assignors to The Patents Corp. A method of treating metal surfaces to prevent corrosion, said surfaces being in the group consisting of iron, steel and zinc, by applying an insoluble chromate in finely divided form in water suspension or in suspension in a solution of chromic acid or dry, then drying if necessary, removing the excess chromate and thereafter applying a coat of one of the group consisting of paints, enamels and lacquers. The treatment increases the adherence of the paint in addition to increasing corrosion resistance.

*Example:*

Steel article is treated for 1 minute in a 1% solution of sulfuric acid at boiling, is rinsed and then a paste of ferric chromate and water is rubbed in and allowed to air dry. The excess powder is brushed or wiped off and paint is applied. The chromate may be pasted with a 5-10 grams/gal. chromic acid solution instead of with water.

# Ben Popper Honored by New York Branch of A.E.S.

The New York Branch of the American Electroplaters' Society in cooperation with many friends and associates of Ben Popper honored him with a banquet and testimonial speeches at the Hotel Pennsylvania, New York City on Saturday evening, May 17. A scroll, printed in gold, was given Mr. Popper to signify the occasion and was signed by the 126 people in attendance

"Ben", as he is affectionately known by his many friends, started his career with the Egyptian Lacquer Mfg. Co. on July 5th, 1901, as an office boy with duties ranging from taking care of fires in the morning to sweeping up at night. In 1904, his ambitions to become a salesman were realized and he was given a territory in New York City where he has worked continuously ever since. Ben was one of the first lacquer salesmen to be elected to the A. E. S. and his membership dates back over 25 years. He has served the Society long and well and Ben is one of the first to arrive at annual meetings greeting the new-comers with a smile and offering helpful advice.

The testimonial dinner was arranged largely through the efforts of *Frank J. MacStoker, Ralph Liguori* and *Henry Levine.* Frank MacStoker acted as toastmaster and did an excellent job. Testimonial speeches were made by *Ralph Liguori, John Rolff, Horace Smith, W. J. R. Kennedy, Dr. Walter R. Meyer, Henry Levine, T. Hofacker,* Vice Pres. of Egyptian Lacquer Mfg. Co., and *O. J. S. de Brun,* Vice Pres., Egyptian Lacquer Mfg. Co.

In addition to a large New York delegation, there were almost a dozen friends from Newark and many from New England. An excellent testimonial was presented by the presence of Ben's friends with other companies in the finishing field. These included *Al Braun,* Agate Lacquer Mfg. Co., *Conrad Frey* and *Thomas Haddow,* Maas and Waldstein Co., and *John Oberender,* Zapon Div., Atlas Powder Co.

Telegrams from friends who were unable to attend were received from *David X. Clarin,* Oakite Products, Inc., *Morton C. Smith; Tom Trumbour,* Metal Finishing, *John E. Sterling,* Past Supreme Pres., A.E.S., Mr. and Mrs. *L. Kornblum,* and *Ben Nadel.*

Ben Popper, who had been unaware of the meeting until only a few days preceding it, was overwhelmed with the many expressions of good will and friendship and Mrs. Bianca Popper, Ben's helpmate over the years that were being honored, was likewise greatly touched by the proceedings. Present, in addition to the aforementioned members of the Egyptian Lacquer Mfg. Co. were the following: *Charles Schlott,* Metropolitan District; *Jack Malool,* Asst. Sales Manager; *Clinton De Baun,* retired; *Arthur Snow,* Philadelphia; *O. Steeger,* Comptroller; and *William Vella,* Metropolitan District.

In response to the testimonials, Ben made the following speech: "Mr. Chairman, Fellow Members of the New York Branch, A.E.S., Honored Guests, Ladies and Gentlemen—or to borrow a now-famous greeting from a well-known man . . . 'My friends'.

"The average man or woman is indeed fortunate who goes through life with two or three sincere friends but as I look around this room and see the faces of so many of you whom I count among my most loyal friends, I feel indeed as though I have been blessed with a larger share of friendships than any man could hope for.

"I do not know what I have done to deserve this splendid tribute. . . . Whatever small contribution of effort I have made to the Society, I have made because I really wanted to. . . . I have worked for the organization because I realized that whatever I could do to help would always be appreciated by you.

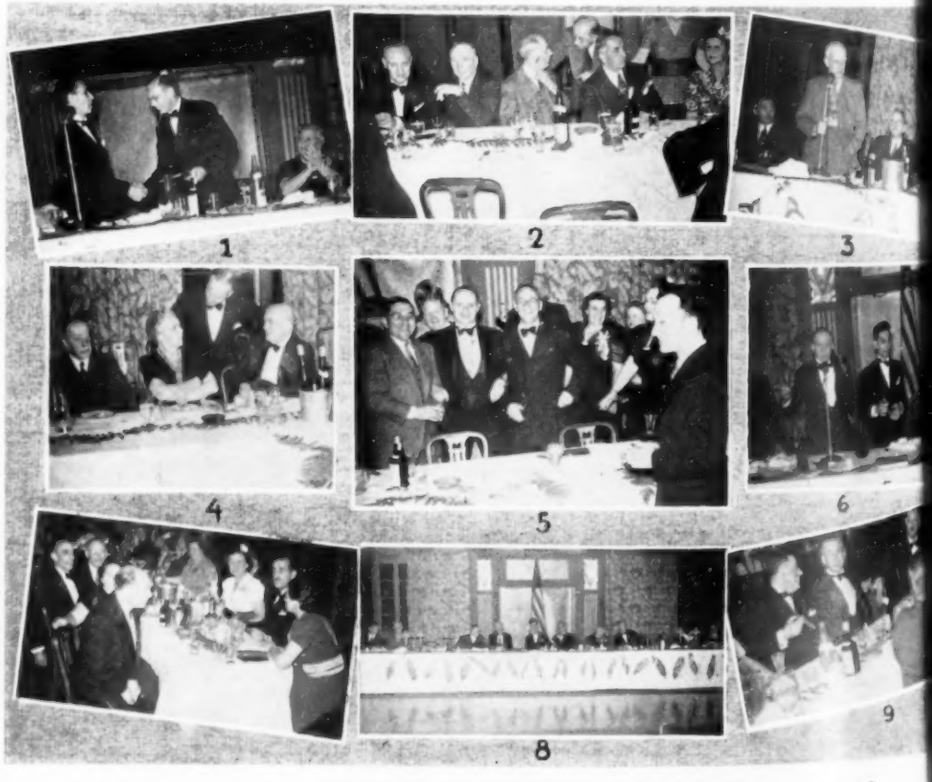
"In passing, please let me say, however, that whenever you have honored me by appointments to a banquet committee, and more lately to the recent National Convention committee, whatever success I may have had in such a capacity has been due in no small measure to your unstinted and splendid cooperation without which I could not have successfully functioned as a committeeman.

"During my thirty years of association with the New York Branch of the American Electroplaters' Society, I have been fortunate in making and keeping so many friendships among my fellow members. . . .

"It is difficult for me to tell you in mere words of my heartfelt appreciation for this wonderful demonstration in my behalf.

"To each of you and most particularly to the committee responsible for the arrangement of this grand affair, I extend my sincere and earnest gratitude.

"Thank you."




1. *Ralph Liguori* (left) awarding Scroll to *Ben Popper* (center); *Mrs. Bianca Popper,* applauding.

2. Left to right, *Al Braun, Ben Cross, A. Henry, Royal F. Clark, Wm. Schneider* and *Mrs. Wm. Schneider.*

3. Left to right. *Dr. Walter R. Meyer; W. J. R. Kennedy,* standing; *Henry Levine* and *John Rolff.*

4. Left to right. *Clinton De Baun, Mrs. T. Hofacker, O. J. S. De Brun* and *T. Hofacker.*

5. *Ben Popper* (center) surrounded by well-wishers.

6. Left to right, *Frank MacStoker,* Toastmaster; *Ralph Liguori* and *Ben Popper,* seated.

7. Left (rear). *Charlie Schlott* and *Phil Morningstar; Izzy Bergen,* front; right, *Mr.* and *Mrs. Arthur Snow* and *Mrs. C. Schlott.*

8. The Speakers' Table.

9. Left to right. *Jack Malool, O. Steeger, Steve Gables; Bill Voss,* foreground.

# NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

### Highly Corrosion Resistant Paint

The U. S. Stoneware Co., 60 E. 42nd Street, New York City, just announced their new "Tygon" paint, which has been developed for the protection of metal, concrete and wood surfaces against corrosion and chemical reactions. It is particularly recommended for jobs involving very severe corrosive conditions that other paints or coatings cannot resist. Some of the principal applications are:

For painting chemical and process equipment, pumps, fans, tanks, etc.

For laboratory walls, tables, etc.

For plating, pickling and etching departments, fume ducts, etc.

As a floor paint, as a coating over building steel, sprinkler piping, etc.

For protection anywhere, against acid spillage, highly corrosive fumes, vapors, etc.

As an industrial lacquer or finish, to impart enduring beauty to any product.

The paint is stated to withstand the action of almost all acids, salts and alkalies, including nitric, hydrofluoric, hydrochloric, sulfuric and chromic acids (concentrated formic and acetic acids alone excepted). Chromium, cadmium, nickel, copper, tin, silver, gold and other plating solutions can be handled with perfect safety.

This paint may be brushed, sprayed or baked. It comes in a wide range of colors, as well as in white, black and "clear." One gallon will cover about 200 sq. ft.

### Substitute for Black Nickel

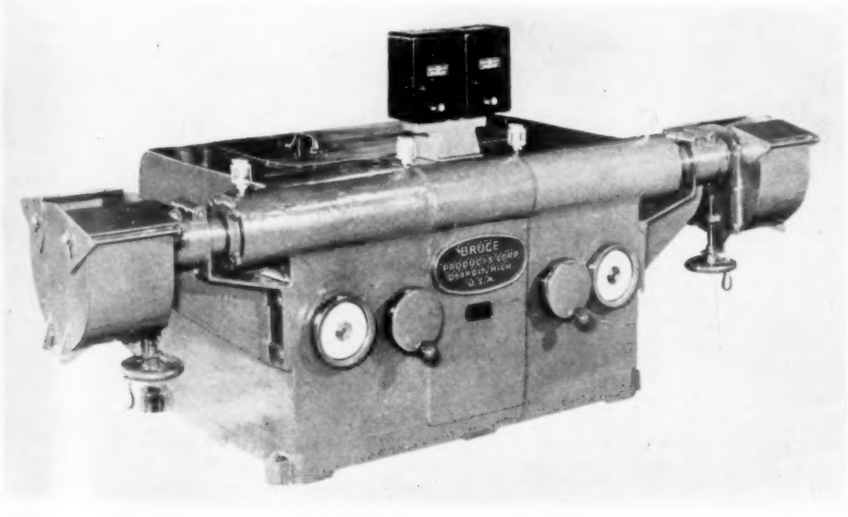
It is announced by the Enthone Co., 442 Elm St., New Haven, Conn., that their "Ebonol Z" process is finding increasing application as a substitute for black nickel plating.

The scarcity of nickel and nickel salts has resulted in a search for a substitute for black nickel, and the suppliers of "Ebonol Z" process state that an adherent jet black coating, which is harder than black nickel deposits, is being obtained with this process. It consists of properly cleaning and acid dipping the work similar to that for plating, followed by deposition of the black deposit in a warm solution of "Ebonol Z" salts in concentration from 4 oz. to 1 lb. per gal. The throwing power of the solution is stated to be excellent and deposits can be made directly upon zinc, cadmium, steel and stainless steel.

### Adjustable High Speed Lathe

Illustrated is a new adjustable high speed type machine recently developed by Bruce Products Corp., 5712 Twelfth St., Detroit, Mich.

This "VAS" model has spindle speed through a range of 1800 to 7000 R.P.M. and is widely used for edge finishing with rubber bonded abrasive wheels, and for experimental work, using polishing, buffing and grinding wheels to obtain various finishes, together with the testing of all types of wheels to determine their rate of deterioration at various speeds.




Adjustable high speed lathe.

### Black on Copper

Alrose Chemical Co., Providence, R. I., originator of the "Jetal" process for blackening iron and steel, announces a new "Electro-Jetal" process. This process is said to give a black rust-proof finish on copper by anodic oxidation. Any metal that can be copper plated can be blackened by this method. After preplating with copper, products are immersed in a special electrolytic oxidizing bath for 2 to 5 minutes. The resulting velvety black surface is claimed

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to be an excellent absorptive base for an after-treatment of oil, wax or lacquer which gives a non-porous, rust-proof finish equivalent to ordinary nickel plate.

The new bath can be operated at any temperature below the boiling point of water, using ordinary steel containers, heated by steam coil. Work can be oxidized on racks, in bulk or baskets. The chemical cost, exclusive of the copper plate, is approximately 25c per thousand sq. ft. of surface. The process, according to the supplier, is practical and is now being used industrially with one firm alone finishing over 260,000 small parts per day!

Samples to illustrate the "Electro-Jetal" finish will be furnished by Alrose Chemical Co. on request.

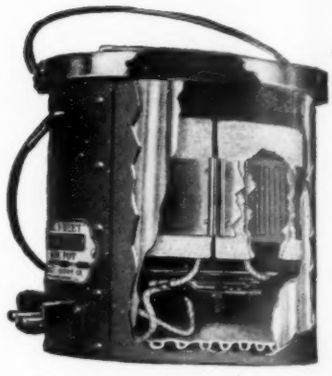
---

*Philadelphia Quartz Co.* of California, Ltd., 8401 Quartz Ave., South Gate, Calif., completed the installation of new equipment in mid-May in a newly completed 7,200 square-foot addition to its South Gate plant for the manufacture of silicates of soda.

The *C-W-C Corporation*, representing a merger of the *Wilder Machine Works* and *H. E. Crozier Co.*, has taken over occupancy of a new plant for producing tool post turrets, bed turrets and lathe collets at 684 North Prairie Ave., Hawthorne, Calif.

### Glue Pots Built to Navy Specifications

Russell Electric Co., 354 W. Huron St., Chicago, Ill., have announced that they are manufacturing glue pots in strict accordance with U. S. Navy Specification No. 41-P-28A. In addition to the usual features, these glue pots will now be available with special copper covers. The appliance cord has been lengthened and the rating of the element has been changed from 110 volts to 115 volts, and 230 volts instead of 220 volts. A feature of the pots is automatic thermostatic control which is stated to keep the glue temperature controlled accurately within 1° of proper temperature. Double asbestos insulation is used



Specification-built glue pot.

to save current. The container is nickel plated to obviate discoloring of the glue and the pot is made of heavy welded steel plate.

### Bright Copper Plating Process

A new bright copper plating process has been developed by Dr. Louis Weisberg, 71 West 45th St., New York, N. Y.

Due to the shortage of nickel, many concerns are thinking seriously of going over to heavy copper deposits followed by comparatively light nickel deposits as a means of saving nickel. For that reason, bright heavy copper deposits will be very advantageous at this time.

Following is a brief summary of the salient facts about this process.

1. The basic ingredients of the solution are copper sulphate, diethylene triamine and ammonium sulphate.
2. The copper is in the bivalent form.
3. The current efficiency at both anode and cathode is practically 100%.
4. The throwing power compares favorably with a cyanide copper solution and is much better than an acid copper solution.
5. The average current density is about 40 amperes per square foot for optimum brightness.
6. The bright plating range extends from practically zero on the one hand up to over 100 amperes per square foot on certain simple types of work.
7. A moving cathode is recommended.
8. Anodes are preferably of electrolytic copper (cathode) although cast copper anodes may be and have been used.
9. Operating temperature is approximately 140° F.
10. Rubber lined equipment—tank and filter are required.
11. Regular filtration is necessary to keep the solution clean.
12. Heating can be provided by means of a copper coil or a Duriron heat exchanger.
13. A cyanide copper flash before plating on zinc or steel is required. This need not be more than a two or three minute flash except possibly on pieces carrying heavy scale such as bumpers where about 0.0001" of cyanide copper is recommended. Either a Rochelle salt solution

or an ordinary cyanide copper solution may be used for the flashing.

The Hanson-Van Winkle-Munning Co., Matawan, N. J., is the sole selling agent for this process.

### Perspiration Retainer

Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa., have announced the development of a perspiration retainer for men working on hot jobs.

Perspiration retainer.

"M.S.A. Coolband" is stated to prevent perspiration from entering the eyes, goggles or glasses, and offers all-around-the-head absorption. It consists of a soft, flexible band which encircles the head, and is claimed to create a cooling effect through constant absorption of perspiration. The band may be disinfected at will, and any part of the band can be quickly and easily wrung out.

Bulletin No. CE-13 describes the band.

### New Quinhydrone pH Meter

Kocour Co., 4720 S. Christiana Ave., Chicago, Ill., have developed a new type quinhydrone pH meter, made especially for the electroplating industry.

The meter features no wires; is compact and portable, and is stated to have rugged meters. It is a direct reading type meter, with no calomel half cell to foul or standard cell to replace. It is stated to be extremely simple in operation; to be fool-proof, and economical to buy and operate.

(Right) New quinhydrone pH meter for electroplating industry.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Miccroplastic has characteristics never before offered in any similar material. Among these are:

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UNUSUALLY LOW VISCOSITY—Miccroplastic is very free-flowing. It is dipped easily—one dip requiring as little as five seconds for submersion and emersion. Because of this quality, Miccroplastic follows every contour and never produces webbing, bridging or air pockets.

As there is never a possibility that solutions can creep under the coating, contamination of baths by chromic acid which might have been trapped under the coating is eliminated. WITH THIS PROTECTIVE COATING MATERIAL, IT IS ALWAYS SAFE TO GO FROM BRIGHT NICKEL TO CHROME WITHOUT RERACKING THE WORK.

CONTAINS HIGH SOLIDS—No other coating material of this type provides the high solids contained in Miccroplastic.

DRIES TO A HIGH GLOSS—Rinsing between baths is extremely easy.

EASY TO APPLY AND REPAIR—Miccroplastic is applied directly on the metal surface without use of primer. If racks should be damaged in process, the damaged portion alone can be easily repaired.

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### Soft Rubber Polishing Wheels

The Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago, Ill., have announced the development of a new type of improved soft rubber polishing wheel. Five different types of polishing abrasives are impregnated into a special rubber binder. In addition a cutting grit is included. This grit can be varied in keeping with the requirements of the particular job to be polished, using a coarse grit where deep marks are to be removed and finer grits for lighter polishing. It is stated that the wheels are proving satisfactory in many cases for preparation of the work previous to plating, eliminating in some cases, all set-up wheels. In a number of cases, the wheels are eliminating cutting down buffing operations.

One of the most valuable applications of rubber polishing wheels is claimed to be the finishing and polishing of tools, dies, jigs and fixtures. Much of the hand drudgery, for example, is stated to be obviated in the finishing of a cavity mold for die

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**BACON FELT CO.** WINCHESTER MASS. ESTABLISHED 1824

Operator using soft rubber polishing wheel.

castings or bakelite molding.

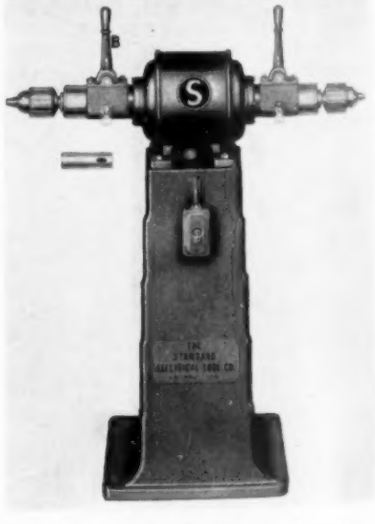
In addition to wheel form, the polishing medium is available in sheet, stick and brick form as well as mounted wheels.

It is important that the wheels be used with a speed below 4000 surface feet per minute, and it is stated that excellent results are being obtained at the low speed of 2000 s.f.m. Less pressure is required in polishing when soft rubber polishing wheels are used, due to the cushioning effect of the bond. In addition, the wheel face can be dressed by any conventional dressing method to any desired contour so that irregularly shaped castings can be polished with ease. Coolants that are non-solvents for rubber can be used.

### Lathe Double End Arrangement

The Standard Electrical Tool Company, Evans & 8th, Cincinnati, Ohio, have added to their line of speed lathes, a double end arrangement as illustrated.

The construction of this unit permits the spindle at each side to be operated at random, starting and stopping one side without interfering with the operation on the opposite end. Incorporated in each spindle housing is a combination clutch and brake which is actuated either through hand lever as illustrated, or by foot pedal control.



Lathe with double end arrangement.

Simultaneous action disengages the clutch and applies the brake, instantly stopping the work spindle, while the motor continues to operate. Slight pressure on the hand lever or foot pedal places the work spindle in neutral position.

The illustration shows this unit equipped with a three-jaw drill chuck on each end of spindle. Optional equipment includes a universal lathe chuck, Morse taper socket or Collet chuck.

Increased production, due to the facility of quickly starting and stopping the work spindle, is reflected by this arrangement. Each work spindle being independent of the motor shaft permits the motor to operate at all times, eliminating frequent starting and stopping, reflecting in lower current consumption and longer motor life with lower maintenance cost. The motor operates only through the toggle switch at front of machine.

Available in sizes of ½, 1 and 2 HP with any standard motor speed, this double end unit serves two operators independently, conserving floor space.

## Manufacturers' Literature

### Cements

Smooth-On Mfg. Co., Dept. 132, 570 Communipaw Ave., Jersey City, N. J., have issued a revised edition of their "Smooth-On" cement handbook containing 40 pages with 170 diagrams, simply and concisely instructing on how to seal various cracks and repair objects, using the company's cement. Some of the uses given are: sealing cracks in castings, stopping leaks in apparatus, patching concrete floors, cellars and walls.

### Chromium Chemicals

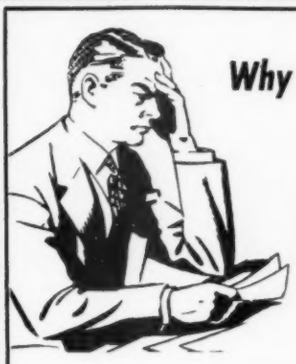
*Mutual Chemical Co. of America*, 270 Madison Ave., New York, have issued a beautifully illustrated book entitled "Chromium Chemicals: Their Discovery, Development and Use." The book is decorated profusely with sketches. The history of chromium and sources of ores are discussed in detail, then the various chemicals of chromium, such as pigments, chrome tanning materials, chromium salts for etching, corrosion resistance and dyeing are described. Chromic acid and uses for chromic acid are also discussed. A list of products sold by the company is appended.

### Electric Grinders

Electric grinders, buffers, drills, etc., are described in detail and attractively illustrated in the new 36 page Catalog No. 43 now being distributed by The Standard Electrical Tool Co., Evans & 8th, Cincinnati, Ohio.

### Electrical Equipment

*Ideal Commutator Dresser Co.*, 1270 Park Ave., Sycamore, Ill., have just published a 24-page catalog in commemoration of their 25th anniversary, which describes and illustrates various equipment made by the company. The equipment includes electric etchers, soldering irons, blast hand cleaners, grinders, commutator dressers, wire strippers and various tools.

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### Protectors for Eyes and Face

Sellstrom Mfg. Co., 615 N. Aberdeen St., Chicago, Ill., issue a 36-page catalog describing and illustrating protective material made by the company to protect both eyes and face from abrasive and injury from light. Included are lenses and variously shaped face shields and helmets for welding, grinding, aviation and general use. Accessories and respirators are also described.

### Resinoid Wheels

An attractive 6-page folder in color recently published by Norton Co., Worcester, Mass., illustrates the use and describes various resinoid wheels for grinding, the various shapes and specifications, as well as advantages of these wheels.

### Rubber Coated Products

*Paramount Rubber Service, Inc.*, 1430 Rosedale Court, Detroit, Mich., have issued a folder illustrating a huge fume stack, which was rubber-lined by the company. Various sizes of anode savers for the use of anode scrap in plating are also described and illustrated.

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*Sodium Metasilicate U. S. Pat. 1898707. Sodium Sesquisilicate U. S. Pat. 1948730, U. S. Pat. 2145749*

EST. 1831

METSO

**METSO CLEANERS**


### Thermometers and Hydrometers

Catalog "C-40" published by George Ruehlel Co., Inc., 103 Menahan St., Brooklyn, N. Y., is a 28-page catalog giving specifications on various hydrometers and thermometers made by the company. These include both plain glass and armor type thermometers. Temperature conversion tables are also given.

### Tool Steels

*Henry Disston & Sons, Inc.*, Philadelphia, Pa., in their catalog No. 100-S, describe various tool steels made by the company. Excellent photographs depict the various steps in the manufacture of the steel. Pertinent details are given on each type of steel offered by the company. This information includes chemical composition, working instructions, such as hardening, annealing, drawing and grinding, and applications for the steel. Useful tables, such as SAE numbers and analyses, weights and hardness conversion tables are appended.

## Communications from Our Readers

### A Communication from Sir Ernest Canning on Historical Aspects of Plating and Motor-Generators

W. CANNING & CO., LTD.
Great Hampton Street
Birmingham 18

14 March, 1941.

The Editor, METAL FINISHING,
Dear Sir,

With reference to the article in your February issue, under the heading "Rectifiers Allow Power Flexibility," by Louis W. Reinken, with particular reference to the details under the heading of "Introduction," I should be glad if your contributor could give me some more information in regard to his statement that Cruikshank demonstrated copper plating on an experimental scale early in the year 1800.

When he says that Faraday invented the motor-generator in 1831, I am afraid he has slightly exaggerated the results achieved at that date.

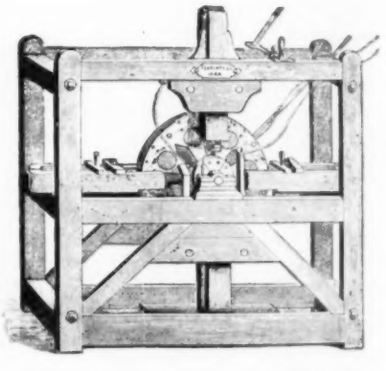
In that year, Faraday discovered that it was possible to generate an electric current by the relative motions of conductors and magnets, and in 1832 he discovered the first chemical law of electrolysis.

His further discoveries between the years 1832-1839 placed electrochemistry on a basis which is as true today as when discovered.

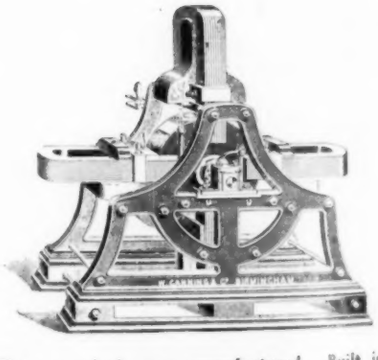
The discovery of the Daniel cell in 1836 provided a ready means for supplying the necessary current, and Elkington of Birmingham, England, developed actual electroplating in 1836. This was followed by an inventor named Jacobi who developed a process of copper deposition in relation to electrotyping in 1840.

Another man named Wright, produced plating solutions containing cyanide. Russell and Woolrich were the first to deposit cadmium electrolytically in 1849, and copper refining was commenced by Elkington in 1860.

So far as can be traced, nickel plating originated in the year 1842 when Professor Botteger found that dense and brilliant de-



**The first dynamo built for electrodeposition. It was built in 1844, and is now at Aston Hall, Birmingham, England.**



**The second dynamo manufactured. Built in 1851. Presented by W. Canning & Co., Ltd., to Birmingham University in 1919.**

posits could be obtained with nickel ammonium sulphate, and it is recorded that a nickel solution made from double nickel salts was actually in use at Grenelle, France in 1849. In 1869 an American, Dr. Isaac Adams re-introduced Botteger's solution which was eventually developed throughout America and plants were installed in England in the latter part of 1873 or not later than January 1874. This went on until the year 1876.

As already pointed out, the earlier efforts of electrodeposition were carried out by means of primary batteries. Actually, the first dynamo ever used in the art of electrodeposition was one made by Woolrich of Birmingham, England, in 1844. This machine was constructed of heavy baulks of timber, erected in rectangular form on which were bolted 4 sets of permanent horseshoe shaped magnets. The armature which was in the form of a disc, revolved between the poles of the magnets and connection was made by copper brushes, similar in principle to present day practice. The machine which was 5' high, 5' long, and 2'6" wide was successfully worked for many years by a firm of Birmingham silversmiths, Messrs. Prime and Sons for the purpose of electrodeposition of silver, and at the present time is in the possession of the Corporation of the City of Birmingham, England, to whom Messrs. Prime eventually presented it. It is now on exhibition at the old Elizabethean mansion in Aston Park, Birmingham, England.

The second dynamo made for the purpose of electrodeposition was also made by Woolrich in 1851 and again worked by Messrs. Prime, eventually passing into the possession of W. Canning and Comp, and was by them presented to the University of Birmingham, where it can still be inspected.

In 1876, another American, Mr. Van Winkle came to Birmingham, England, bringing with him a new plating dynamo. The frame of this machine was barrel shaped and the magnet pieces were hollow and arranged for water circulation to keep them cool. The commutator was in two sections, and a leather band from the armature spindle drove a kind of governor which made contact in a mercury cup when the machine was running at full speed, and disconnected the machine in the event of the speed falling. This device was supposed to prevent the machine reversing polarity, but in actual practice was not a very great success.

It will thus be seen that although my company has been manufacturing dynamos and motor-generators and electroplating equipment for a very considerable time, Mr. Reinken in mentioning the year 1838 as the year when we were building dynamos for electroplating is giving us credit for something to which we are not entitled.

The House of Canning was founded in the early nineteenth century and it was not until some time between 1880 and 1883 that my company concentrated its attention upon plant and materials for the development of the electroplating industry.

Yours truly,

Ernest R. Canning,

Chairman.


THE DIAL DOES IT

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★ BUFFING
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Better and more uniform finish invariably is the result with HAMMOND'S new "VRO" Variable Speed Polishing Lathe . . . because it keeps peripheral speed constant as wheels wear down.

The dial control . . . mounted directly in front of the operator . . . does it. It's sensitive to the slightest touch . . . gives you instant, point-by-point speed control all the way from 1500 to 3000 RPM. The "VRO" is big, tough . . . built for hard service . . . yet incorporates the lateset design features. The "overhang" permitting awkward shapes to be brought up to the wheel without difficulty is an outstanding feature.

But you'll want to know all about it . . . so write today for BULLETIN No. GP-30.

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**Mr. Reinkin's Reply**

THE W. GREEN ELECTRIC CO. Inc.
Green Exchange Building
130 Cedar Street
New York

April 28, 1941.

Dear Dr. Meyer:—

Many thanks for allowing me to read Sir Ernest Canning's interesting letter. I hope you will find space to publish it in full in the next issue of "Metal Finishing."

In the introduction to the article "Rectifiers Allow Power Flexibility," which appeared in the February issue of "Metal Finishing," certain statements were made regarding the early work of Cruikshank and Faraday. The source for these statements is that old standby the "Encyclopedia Britannica." (The following excerpts and paraphrases are from the 14th edition, Printing J, Volume 8, Pages 174, 5; 188, 9; 198, 316, et seq.)

"Cruikshank (1745-1800) soon found that metallic salts in solution could be decomposed in the same way. For example, with the solution of copper sulphate, copper is deposited on one wire, and sulphuric acid and oxygen appear on the other."

The context indicates that Cruikshank very likely attached more importance to the dissociation phenomenon than to the incidental deposition of copper. However, whether he realized it or not, he had performed the first recorded example of electroplating and his achievement led directly to the process of electroplating. Hisinger, Berzelius and Sir Humphry Davy, investigated the phenomenon of electrolysis before Faraday turned his inquiring mind to the subject. About 1830 Faraday began the first exact quantitative study of electrolytic phenomenon. The results of these researches were included in his "Experimental Researches" published in 1833, and are summed up in what we now refer to as "Faraday's Laws." These Laws, as Sir Ernest says in his letter, "placed electrochemistry on a

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They furnish reserve strength to carry you over the hump on tough cleaning jobs. They save time and speed up production.

Investigate Cowles dependable, economical Metal Cleaners. There is a Cowles Cleaner for every job—and they are all backed up by Cowles Technical Service, which is our assurance to you that:

*"Cowles Metal Cleaners will get you out of trouble and keep you out of trouble."*

**THE COWLES DETERGENT COMPANY**
*Metal Cleaner Department*
**7016 EUCLID AVENUE CLEVELAND, OHIO**

COWLES CLEANERS

*"Cleaner Surfaces for Better Finishes"*

basis which is as true today as when discovered."

With regard to generators or dynamos, the Britannica has the following to say—"In 1831 Faraday found that when a current is started in a coil of wire a momentary current is induced in another nearby coil. . . . He mounted a copper disc between the poles of a magnet . . . and when the disc was made to rotate with uniform velocity, the galvanometer indicated a steady current. This apparatus was the first dynamo, or electric generator, and all the generators now used for the production of currents for technical purposes work on the same principle."

I note that Sir Ernest says in his letter that the House of Canning did not manufacture generators for electroplating until some 40-odd years after the date mentioned in my article. Since Sir Ernest knows far better than I do the history of his company, I can only apologize for my error and stand in the corner.

Yours very truly,
L. W. Reinken

## New Books

*Prevention of the Failure of Metals Under Repeated Stress.* By the Staff of Battelle Memorial Institute. Published by John Wiley & Sons, Inc., New York. Size 9" x 6"; 264 pages. Price $2.75.

A valuable book discussing the timely subject of fatigue failure which is extremely important in the present defense program.

The book is beautifully illustrated with photographs and photomicrographs of parts which have been subjected to fatigue failure. The nature of fatigue and factors contributory to fatigue are thoroughly discussed. Detection of fatigue cracks and methods of fatigue testing are considered.

The book will prove to be exceedingly valuable to design engineers, machine shop superintendents, inspectors and metallurgists.

*Patent Fundamentals.* By Leon H. Amdur. 1941. Published by Chemical Publishing Co., Inc., New York. Size 8¾" x 5¾"; 293 pages. Price $4.00.

The book is written simply and clearly for the industrial engineer, student and inventor, which clearly discusses the basic principles underlying the complexities of patent law.

The following chapter headings suggest the type of information discussed in the book: Types of Inventions; Nature of a Patent; How Patents are Classified; Preparation and Prosecution of Applications; Invention as Defined by Patent Claims; What is Invention; Utility, Immorality and Frivolity; Plant Patents; Dealings in Patents.

*Mechanism.* By Stanton E. Winston. 1941. Published by American Technical Society, Chicago, Ill. Size 8½" x 5½"; 365 pages.

This book is a companion text to the author's "Machine Design", and it deals with mechanical movement and the combinations of links or machine elements by which these movements are effected.

The basic principles of the three ordinary modes of transmission of motion are developed, and a limited number of types of mechanisms of each mode are studied. In analyzing the relative motion of the elements of these mechanisms, the graphical method of analysis, rather than the algebraic method, is stressed. The text includes many graphical constructions which are fully explained, and many illustrative examples with their solutions. The text material is presented in such a way as to help the student develop an orderly process of thinking and an ability to analyze and visualize that will permit him to cope with other kinematical problems.

Chapter headings are: Fundamental Considerations; Motion; Instant Centers and Instantaneous Motion; Relative Velocities in Linkwork; Velocity Diagrams; Wrapping Connectors; Direct-Contact Mechanisms; Toothed Wheels or Gears; Trains of Mechanism; Cams.

*The Modern Theory of Solids.* By Frederick Seitz. First Edition. Published by McGraw-Hill Book Co., Inc., New York. Size 6" x 9"; 680 pages. Price $7.00.

This book which is written for students of physics and chemistry, engineers and metallurgists with mathematical leanings, should prove valuable in understanding the modern concepts of the solid state. The book is not simple to understand, as it presupposes (as would be the case when mathematical treatment is made) a knowledge of the field of mathematics.

Chapter headings include the following: Empirical Classification of Solid Types; The Classical Theory of Ionic Crystals; The Specific Heats of Simple Solids; The Free-Electron Theory of Metals and Semi-Conductors; Quantum Mechanical Foundation; Approximate Treatment of the Many-Body Problem; Molecular Binding; The Band Approximation; Approximational Methods; The Cohesive Energy; The Work Function

and the Surface Barrier; The Excited Electronic States of Solids; The Electronic Structure of the Five Solid Types; The Dynamics of Nuclear Motion; Phase Changes; Theory of Conductivity; The Magnetic Properties of Solids; The Optical Properties of Solids.

Although the book is a large one, a number of important topics, such as, plastic properties of solids, are only touched upon.

*Spectrochemical Abstracts Vol. II* 1938-1939. By Ernest H. S. van Someren. • February 1941. Published by Adam Hilger, Ltd., 98 St. Pancras Way, London, N. W. 1, England.

This volume covers the spectrochemical abstracts for 1938-1939 with a few important earlier papers being included. The books on this subject published in 1940 are also included. Both the author index and subject index are given. The subject index covers all fields in which spectrochemical analysis is used.

## Obituary

### Allen V. Potter

Allen V. Potter, Sales Representative, for the Speer Carbon Company, Saint Marys, Penna., covering Detroit and the nearby area during the past five years, died suddenly April 25, at the age of 36.

His pleasant personality and desire to give service made him many friends. His ten years in plant development work accounted for his excellent technical background. His associates will miss a good friend and able worker.


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## Associations and Societies

### Electrochemical Society

The fall meeting of the Society will be held in Chicago, October 1-4, at the Hotel Knickerbocker. *L. G. Van de Bogart* is head of the local committee sponsoring the meeting. There will be five technical sessions, three of these will be devoted to electrodeposition, one to electro-organic and one to miscellaneous topics.

The major theme of the meeting will be electrodeposition, and reviews of the existing knowledge on various plating solutions and theoretical aspects of electrodeposition, are being prepared by prominent members of the Society.

### The Society for Metal Finishing

A technical group in Rockford, Ill., have formed "The Society for Metal Finishing," and *J. Walker Eaton* of Elco Tool & Screw Corporation of Rockford, was elected president; *William J. Erskine* of National Lock Company, vice-president, and *Lawrence P. Ray* of Barber-Colman Company, secretary and treasurer.

Others active in the organization are *Swan W. Broman* of American Cabinet Hardware Corp., *J. W. Fitzgerald* of Atwood Vacuum Machine Co., and *John Readette* of Sheets Rockford Silver Company. Representatives of almost every metal working plant in the city are affiliated with the society, which holds its regular meetings the second Monday evening of each month.

The society is interested in both organic and inorganic finishing and has been addressed during the spring by *Vincent Mattacotti* of Hanson-Van Winkle-Munning Co., Matawan, N. J., *Edwin C. Rinker* of Oakite Products, Inc., New York, and *James Robinson* of the Rockford Electrical Equipment Company.

The society will remain inactive during the summer until the second Monday in September. However, a course in electrochemistry and electroplating which the organization helped to inaugurate in connection with the national defense program, will continue through the summer months.

### American Electroplaters' Society

#### Los Angeles

An open discussion dealing with the growing scarcity of essential metals which culminated in a decision of the branch to recommend that the Supreme Society take additional measures to assure a continuation of supplies of metals to job plating shops that are not included in the "essential industry" class featured the May 14 meeting of Los Angeles Branch.

The subject was introduced by *Marcus Rynkofs* who declared that the situation was reaching a stage where ". . . we must do something about it or be prepared to go out of business."

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Mr. Rynkofs emphasized the seriousness of the situation by stating he saw a possibility of a breakdown of the plating industry on the west coast unless the priority board in Washington can be persuaded to allot to electroplaters sufficient supplies of nickel, nickel salt, cadmium oxide, cadmium, zinc, zinc cyanide and other materials, regardless of whether the shop operators are engaged in national defense work.

In seconding the motion, *Bruno Schindler* pointed out that the Supreme Society had already taken some steps to call the situation to the attention of the government, but declared himself in favor of placing the branch on record as a means of impressing the officers of the Supreme Society with the gravity of the problem on the Pacific Coast and urging them to renewed efforts for obtaining release of essential metals.

New officers of the branch which were installed at this meeting were: *Don Bedwell*, president; *Frank C. Rushton*, vice-president; *Ervin Frauenhoff*, secretary-treasurer; *E. R. Holman*, librarian; and *Carroll McLaren*, sergeant-at-arms. Mr. Holman, who is in his fourth term, was presented with a brief case.

## American Foundrymen's Association

### *American Foundrymen's Association Elects New Officers and Directors*

At the annual business meeting of the American Foundrymen's Association held Wednesday morning, May 14, at the Hotel Pennsylvania, New York City, the following were elected officers of the Association:

President to serve one year:

*H. S. Simpson*, National Engineering Co., Chicago, Ill.

Vice President to serve one year:

*D. P. Forbes*, Gunite Foundries Corp., Rockford, Ill.

Directors to serve for three years:

Retiring President *L. N. Shannon*, Stockham Pipe Fittings Co., Birmingham, Ala.

*R. J. Allen*, Worthington Pump & Machinery Co., Harrison, N. J.

*J. G. Coffman*, Los Angeles Steel Casting Co., Los Angeles, Calif.

*W. J. Corbett*, Atlas Steel Casting Co., Buffalo, N. Y.

*M. J. Gregory*, Caterpillar Tractor Co., Peoria, Ill.

At a meeting of the Board of Directors of the Association on May 15, the staff officers of the Association were appointed. *C. E. Hoyt*, Executive Vice President, Treasurer and Manager of Exhibits, is relinquishing his duties as Executive Vice President and Treasurer, and *C. E. Westover*, Burnside Steel Foundry Co., Chicago, has been appointed to these offices. Mr. Hoyt retains his position as Exhibit and Convention Manager of the Association.

The newly elected Executive Vice President and Treasurer comes to the Association well qualified to carry on and direct the work because of his knowledge of the industry and the Association. A native of Lincoln, Nebr., he entered the foundry industry following graduation from the University of Nebraska, Lincoln, the industry in which his father had been engaged for many years.

At first he engaged in the manufacture of gray iron and non-ferrous castings. Later he became associated with the Omaha Steel Works, Omaha, Nebr., in the steel foundry, and served in turn as works manager, Denver plant, American Manganese Steel Div., American Brake Shoe & Foundry Co.; superintendent, Otis Elevator Co., Buffalo, N. Y.; superintendent, Farrell-Cheek Steel Foundry Co., Sandusky, O.; and finally, as works manager, Burnside Steel Foundry Co., Chicago, from which position he is resigning to assume his new position on July 1.

Mr. Westover has been active in the work of the American Foundrymen's Association, serving as a member of committees and in 1939 as chairman of the Chicago Chapter of that organization.

In addition to the above appointment, *R. E. Kennedy* was re-elected Secretary, *N. F. Hindle*, Assistant Secretary, *E. O. Jones*, Director of Safety and Hygiene, and *Jennie Reininga*, Assistant Treasurer.

# Personals

### Puritan Mfg. Co. President Enters Active Army Duty

*Lieutenant Colonel Edward L. White*, president of *The Puritan Manufacturing Co.*, Waterbury, Connecticut, manufacturers of metal cleaners and buffing compositions, has taken an indefinite leave of absence. He has returned to active duty with the United States Army in the office of The Chief of Ordnance to which he has long been assigned as a Reserve Officer. Although the Puritan Manufacturing Co. regrets this loss, it realizes the need of the nation for experienced men during the present emergency. Until January 1st last, Colonel White was National President of The Reserve Officers Association of The United States. He resigned this position believing he would be of greater aid to his country and the national defense program on active duty.

Lieut. Col. Edward L. White

*George B. Svenson*, head of the *Platers Supply Co.*, Cleveland, Ohio, has rejoined his old organization the *Hanson-VanWinkle-Munning Co.*, of Matawan, N. J., manufacturers of electroplating equipment and supplies. Mr. Svenson will represent the HVWM Co. in Ohio with his headquarters in Cleveland. The Platers Supply Co. continue under the direction of his son, *George B. Svenson*, Jr.

*Allan A. Lubitz*, President of the *American Firstoline Corporation*, Long Island City, N. Y., has taken over the general sales management for the domestic and export markets of the Gulton Metal Refining & Chemical Corporation, manufacturers of non-ferrous metals, especially zinc, lead and lead alloys, as well as anti-friction bearing metals. The chemical division of the company manufactures French process zinc oxides for all pharmaceutical, cosmetic and industrial purposes, iron oxide red, venetian red, synthetic ochres, zinc carbonate, etc.—Mr. Lubitz has been specializing in the chemical field for over 20 years. His many friends in the trade, both in America and abroad, will be glad to learn about his increased activities.

*Joseph B. Kushner*, consultant in metal finishing, has announced the removal of his laboratories and offices from 126 W. 32nd Street to 114 East 32nd Street, New York. Mr. Kushner is working on a development which he hopes will be of great interest to electroplaters, and which will be completed by early Fall. In the meanwhile, he is conducting his regular analytical, consulting and development work for the metal finishing industry at his new offices.

*John D. Sullivan*, chief chemist, *Battelle Memorial Institute*, Columbus, Ohio, has been elected chairman of the Electrothermic Division of the Electrochemical Society, an international group of industrial scientists.

The aims of the Electrothermic Division are to advance the theory and practice of the electrometallurgy of metals and alloys, the electrothermics of ceramic products and other mon-metallics, and the design, operation, and use of the electric furnace.

According to Mr. Sullivan, electrochemistry has made available new materials, has rendered it possible to handle materials not workable by other means, and has cheapened the production of many other articles of wide application.

In addition to his membership in the Electrochemical Society, Mr. Sullivan is a member of the following technical societies: American Ceramic Society, American Institute of Mining and Metallurgical Engi-


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PIPE, VALVES, FILTERS, PUMPS, EXHAUSTERS, ETC.

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**BRIGHT NICKEL PROCESS**

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ELIMINATES COLOR BUFFING—RE-CLEANING—RE-RACKING.
AN IDEAL BASE FOR CHROMIUM. EXCELLENT THROWING POWER.
NO SPECIAL SOLUTIONS OR CHANGES IN EQUIPMENT REQUIRED.
EASY TO CONTROL—LOW IN COST—SUCCESSFUL—PRACTICAL.

Uniform results obtained on all classes of work in still tanks or mechanical barrels. Excellent for zinc die-castings. Any cold nickel solution of standard formula will with the addition of NEW IMPROVED LUSTREBRIGHT give brilliant, lustrous, adherent deposits. Guaranteed not to harm plating solution or cause plate to peel, become brittle or produce streaky deposits. Illustration shows unbuffed deposits produced before and after addition of NEW IMPROVED LUSTREBRIGHT. Write for complete information.

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An inhibiting agent for Sulphuric Acid strip baths that—

**PREVENTS PITTING AND ROUGHENING OF THE BASE METAL**

(Steel, brass, zinc die castings, heavy zinc and lead bearing alloys)

**STRIPODE**

Reduces Finishing Costs to a Minimum
Reduces Stripping Time by 50% or More in Many Cases
Reduces Your Scrap Loss
Strips Plating Racks
Saves Acid

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neers, American Foundrymen's Association, American Institute of Chemists, American Society for Testing Materials, British Ceramic Society, Deutsche Chemische Gesellschaft, Deutsche Keramische Gesellschaft, London Chemical Society, and the Society of Glass Technology. Mr. Sullivan is a Trustee of the American Ceramic Society and Chairman of its Committee on Publications. He is also Chairman of Committee C-8 on Refractories of the American Society for Testing Materials.

## Business Items

### Novel Features at the Platers' Convention

The coming convention of the American Electroplaters' Society in Boston, June 9-13, will be enlivened by several novelties instituted by the *Hanson-Van Winkle-Munning Company* of Matawan, N. J. The outstanding feature will be the "HVWM Boston Tea Party". All visitors to the HVWM rooms in the Statler Hotel will receive a "Lucky Number Tea Bag" which will give them a chance on any of five handsome prizes to be presented at the annual banquet. In addition, all visitors will receive an HVWM teaspoon and an HVWM "T" Puzzle. These diversions will add measurably to the week's entertainment.

As in the past years, the HVWM Official Convention News will be published daily, giving visitors up-to-the-minute news on convention activities, educational and social. This publication is distributed free to all delegates and guests at the convention.

*The Hanson-Van Winkle-Munning Co.*, Matawan, N. J., manufacturers of electroplating equipment and supplies has rented the plant of the *Fisher Bag Company* in Matawan, for use as a storage warehouse.

*Metals Protection Corp.*, Indianapolis, Ind., have opened a plant at 425 S. State Avenue, above city, for the production of buffing and polishing compounds. In addition to this activity, the company will carry a complete line of buffs and wheels and plating supplies. The Metals Protection Corp. was incorporated 20 years ago, and owns patents on chromium plating. *P. C. Cullom* is president; *Thomas C. Batchelor*, vice-president and the production of buffing and polishing compounds will be in charge of *Robert Piscator*.

The Philadelphia office of the *Pangborn Corp.*, is now located at 901 Beury Bldg., 3701 N. Broad Street. *Forrest G. Sharpe*, formerly assistant to the sales manager, has been appointed Philadelphia sales engineer to fill the vacancy caused by the sudden death on April 14th of *William T. Randall*.

*Wilfred S. McKeon* has recently returned from Canada where he made arrangements for McKeon's "Liquid Sulphur" to be manufactured in Canada. Along with other Cana-

dian distributors, this product will be handled by *Clark Industrial Supplies Ltd.*, 3194 Dundas St. W., Toronto. The product being made in Canada is identical with that made at the home plant in the United States, and the product is recommended for stripping copper as well as many oxidizing applications.

*H. Tom Collord*, president of *Paramount Rubber Service, Inc.*, 1430 Rosedale Court, Detroit, Mich., has announced that the company is installing a new department for molding rubber. The department will have a 40" mill., 50 h.p. motor, a 3" extruder and a bank of presses, 12 to 24 inches. Patents are pending on improved methods for molding to precision, and for example, rubber-covered rolls are produced that require no grinding for accuracy. The same is said to apply to tubing for special and technical applications.

### Handy and Harman Elect Officers

At the organization meeting of the Directors of Handy & Harman held April 29th, 1941, the following officers were re-elected: *Cortlandt W. Handy*, Chairman; *G. H. Niemeyer*, President; *R. H. Leach*, Vice-President; *H. W. Boynton*, Treasurer; *H. W. Spaulding*, Secretary. *Judson C. Travis* continues as Assistant to the President; *R. F. Drew*, Manager Providence Plant; *F. L. Spies*, Manager New York Plant. *F. C. Jones*, formerly Assistant to *J. C. Travis*, was appointed Manager of the Bridgeport, Conn. Plant. *J. L. Christie* was appointed Metallurgical Manager. *J. W. Colgan*, Manager of the Toronto, Canada Plant (subsidiary) will become Sales Manager of the parent company.

At the organization meeting of Handy & Harman of Canada, Ltd., held the same day, the following officers were re-elected: *G. H. Niemeyer*, President; *R. H. Leach*, Vice-President; *H. W. Spaulding*, Secretary-Treasurer. *Thomas H. Gallagher*, formerly in charge of the Chicago Sales Office of the parent company, was appointed Assistant Treasurer of the corporation and Manager of the Toronto, Canada Plant.

## News from California

*By Fred Herr*

*S. L. Cole*, sales manager, and *E. A. Locke*, electrical engineer, of the Chicago staff of *Chas. F. L'Hommedieu & Sons Co.*, attended the sessions of the Western Metal Congress at Los Angeles May 19 to 23. They also participated in the discussions of the American Foundrymen's Association which met in a session of its own on May 23, and visited the Western Metal Exposition in the Pan Pacific Auditorium, Los Angeles, where the L'Hommedieu Co. sponsored a booth featuring plating and polishing equipment and supplies.

Accompanied by *Clarence E. Thornton*, Los Angeles branch manager of the firm, the Chicago executives visited various industrial plants in Southern California during their week-and-a-half stay.

The C. I. O. strike which closed the *Price-Pfister Co.* foundry at Los Angeles in April was settled with the granting by the company of wage raises totaling $27,000 annually to the 185 workers. Negotiations which led to the settling of the strike were carried on by *Lyman M. Sisley*, federal conciliator.

The pact provides blanket raises of 5 cents per hour to all employes and additional pay increases to 27 employes under reclassification.

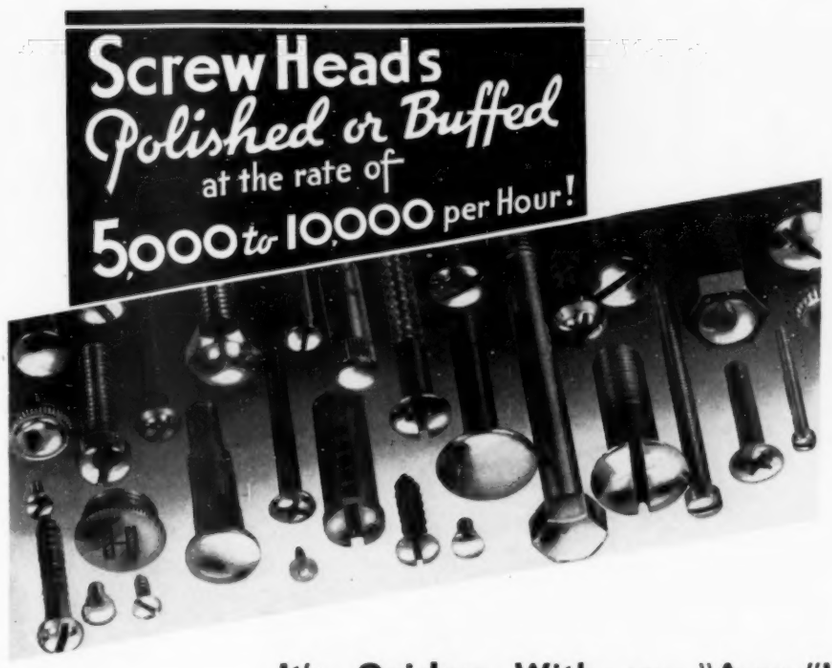
The company agreed to a "modified preferential shop" plan under which employes are hired from union ranks, although no closed-shop provision is included in the agreement.

*The Service Enameling Co.*, 1015 South Figueroa St., Los Angeles, has completed installations of baking ovens and auxiliary equipment for engaging in the enameling business. The plant includes 7500 square feet of floor area.

*Metalcraft Products Co.*, 210 East Washington Blvd., Los Angeles, manufacturers of metal stampings, furniture hardware, etc., is erecting an 8,000 square foot addition which is expected to be ready for occupancy about June 15.

*The American Metal Rolling Co.* of Los Angeles has taken over a building at 1619 South Alameda St., where it has available 28,000 square feet of floor area for the production of aircraft parts and tire rims.

*The Kinney Aluminum Foundry Co.* has been founded at Los Angeles to manufacture aluminum alloy castings and forgings. The first group of buildings, now under construction at 2019 Bay St., will contain approximately 50,000 square feet of floor area. Officers of the new firm are *Wendell H.* and *Roland T. Kinney*, president and vice-president, respectively, of the Kinney Iron Works of Los Angeles.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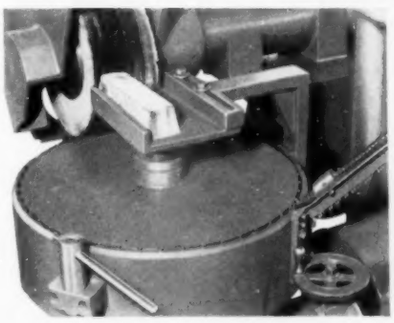

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This is, of course, but one of the many types of Acme polishing and buffing machines in widespread use for speeding up production and reducing operating costs. If you have a buffing or polishing problem, the chances are there is an Acme machine that will solve it.

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# Supply Prices, May 23, 1941

## Anodes

**Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.**

COPPER: Cast, elliptical, 15" and longer ..... .25⅛c. per lb.
Electrolytic, full size, .22⅞c; cut to size .22⅞c. per lb.
Rolled, oval, straight 15" and longer .23¼c. per lb.; curved ..... .24¼c. per lb.
BRASS: Cast, 80-20, elliptical, 15" and longer .... .23⅝c. per lb.
ZINC: Cast, 99.99, 16" and over ..... 15¼c. per lb.
NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus cast 47c.; Rolled, depolarized ..... 48c. per lb.
SILVER: Rolled, .999 fine per Troy oz. ..... 38c. per oz.

## Chemicals

***These are manufacturers' quantity prices and based on delivery from New York City.***

| | | |
|---|---|---|
| Acetone, C.P., drums, l.c.l. | lb. | .08 |
| Acid, Boric tech., 99.5% gran., bbls. | lb. | .0615 |
| Chromic, 99%, 100 lb. and 400 lb. drums, l.c.l. | lb. | .17¼ |
| Hydrochloric (muriatic) Tech., 20°, carboys, wks. | lb. | .0270 |
| Hydrochloric, C.P., 20°, bottles | lb. | .19 |
| Hydrofluoric, 30% bbls. | lb. | .06-.06½ |
| Nitric, 36°, carboys 1-9, wks. | lb. | .0595 |
| Nitric, 42°, carboys 1-9, wks. | lb. | .0745 |
| Oleic (Red Oil), distilled, drums | lb. | .10½-.12¼ |
| **Oxalic, bbls. l.c.l.** | lb. | .14 |
| Stearic, distilled, double pressed, bags | lb. | .12¾-.14½ |
| single pressed, bags | lb. | .12¼-.14 |
| triple pressed, bags | lb. | .15½-.17½ |
| Sulphuric, 66°, carboys 1-9, wks. | lb. | .0245 |
| Alcohol, Amyl, (Fusel oil, ref'd), l.c.l., drums | lb. | .16-.17½ |
| Butyl-normal, l.c.l., drums | lb. | .105-.115 |
| Denat., S.D. #1, 190 pf., 1-18 drms, wks. | gal. | .35 |
| Diacetone, tech., drums, l.c.l. | lb. | .10½-.11½ |
| Methyl, (Methanol), 95%, drums, l.c.l. | gal. | .38 |
| Propyl-Iso, 99%, drums, l.c.l. | gal. | .43-.47 |
| Propyl-Normal, drums, wks. | gal. | .70 |
| Alum, ammonia, granular, bbls., works | lb. | .035 |
| Potash, granular, bbls., works | lb. | .0375 |
| Ammonia, aqua, 26°, carboys | lb. | .05¼ |
| Ammonium, chloride (sal-ammoniac), white, granular, bbls., wks. | lb. | .0445 |
| Sulphocyanide (thiocyanate), pure, crystal, kegs | lb. | .65 |
| Sulphocyanide (thiocyanate), tech., kegs | lb. | .40 |
| Antimony Chloride (butter of antimony), sol., carboys | lb. | .17 |
| Barium Carbonate, ppted., bags, l.c.l., works | lb. | .025 |
| Benzene (Benzol), 90%, drums, works | gal. | .19 |
| Butyl Lactate, drums | lb. | .235 |
| Cadmium Oxide, l.c.l., bbls. | lb. | .95 |
| Calcium Carbonate (Ppted. chalk), c.l., wks. | lb. | .02¾ |
| Carbon Bisulfide, l.c.l., 55 gal. drums | lb. | .05¾ |
| Carbon Tetrachloride, l.c.l., drums | gal. | .73 |
| Chromic Sulphate, scale, 100 lb. drums | lb. | .45 |
| Cobalt Sulphate, drums | lb. | .71 |
| Copper, Acetate (verdigris), bbls. | lb. | .22-.23 |
| Carbonate, 52-54%, bbls. | lb. | .16½ |
| Cyanide, Tech., 100 lb. bbls. | lb. | .34 |
| Sulphate, 99%, crystals, bbls., 1-5 | lb. | .0535 |
| Cream of Tartar (potassium bitartrate), gran., kegs | lb. | .53½ |
| Crocus Martis (iron oxide) red, bbls. | lb. | .08¼ |
| Dibutyl Phthalate, drums, l.c.l. | lb. | .195 |
| Diethylene Glycol, drums, l.c.l., works | lb. | .155 |
| Dextrin, white, bags, F.O.B. Chicago | lb. | .0395 |
| Emery (Turkish) | lb. | .08 |
| Ethyl Acetate, 85%, l.c.l., drums, works | lb. | .075 |
| Ethylene Glycol, l.c.l., drums, works | lb. | .15½-.18½ |
| Monoethyl ether, dms., l.c.l., wks. | lb. | .125-.155 |
| Gold, Chloride, yellow, bottles | oz. | $19.25 |
| Cyanide, potassium 41%, bottles, wks. | oz. | $14.20-$15.45 |
| Gum, Arabic, white, powder, bbls. | lb. | .20-.21 |
| Hydrogen Peroxide, 100 volume, carboys | lb. | .16-.18½ |
| Iron Sulphate (Copperas), cryst., bbls., 1-4 wks. | lb. | .02 |
| Lead, Acetate (Sugar of Lead), crystals, bbls. | lb. | .11 |
| Oxide (Litharge), com., powdered, bbls. | lb. | .08¼ |
| Magnesium Sulphate (Epsom Salts), tech., bbls. | lb. | .018 |
| Mercury Bichloride (Corrosive Sublimate), crys. | lb. | $2.19 |
| Mercuric Oxide, tech., red, powder, bbls. | lb. | $2.81 |
| Nickel, Carbonate, dry, bbls. | lb. | .36-.36½ |
| Chloride, bbls. | lb. | .18-.20 |
| Salts, single, 425 lb. bbls. | lb. | .135-.145 |
| Salts, double, 425 lb. bbls. | lb. | .135-.145 |
| Paraffin, refined, bgs., 123-125 a.m.p., c.l. | lb. | .057 |
| Perchlorethylene, drums, l.c.l. | lb. | .08½ |
| Phosphorus, red, cases | lb. | .44 |
| yellow, cases | lb. | .23-.25 |
| Potash, Caustic, 88-92%, flake, drums, works, c.l., | lb. | .07 |
| Potassium, Bichromate, crystals, casks | lb. | .09¼ |
| Carbonate (potash) calc., wks. drums | | .06¾ |
| Cyanide, 94-96%, dom. dms., wks. | lb. | .55 |
| Pumice, ground, 1½ F. & coarser, bbls., wks. | lb. | No price |
| Quicksilver (Mercury), dom. 76 lb. flasks, net | flask | $183. |
| Rochelle Salts, crystals, bbls. | lb. | .40 |
| Rosin, gum, B, bbls., dock | lb. | .0215 |
| Silver, Chloride, dry, 50 oz. lots | oz. | .37½ |
| Cyanide, 100 oz. lots | oz. | .33¾ |
| Nitrate, 100 oz. lots | oz. | .24 |
| Sodium, Carb. (soda ash), light, 58%, bags | lb. | .0208 |
| Cyanide, 96%, dom. 100 lb. drums | lb. | .15 |
| Hydroxide (caustic soda) 76%, flake, l.c.l. | lb. | .0490 |
| Hyposulphite, crystals, bags, wks. | lb. | .0250 |
| Metasilicate, granular, 1-9 bbls. | lb. | .0335 |
| Nitrate, rfd., gran., bbls., wks. | lb. | .029 |
| Phosphate, tribasic, tech., bbls., wks. | lb. | .0295 |
| Pyrophosphate, anhydrous, bags, l.c.l. | lb. | .0560 |
| Sesquisilicate, 1-9 drums | lb. | .0425 |
| Stannate, drums | lb. | .365 |
| **Sulphate, anhydrous, bbls., works** | lb. | .0215 |
| Sulphocyanide, drums | lb. | .28-.47 |
| Sulphur, Flowers, U.S.P., bbls., l.c.l. mine | lb. | .0335 |
| Tin Chloride, crystals, kgs. | lb. | .39½ |
| Toluene (Toluol), 2°, ind., drums, works | gal. | .32 |
| Trichlorethylene, drums, l.c.l., zone 1 | lb. | .08½ |
| Tripoli, air floated, bgs., c.l., wks. | ton | $26.00 |
| Wax, Bees, white, bleached, slabs, 1-5 cases | lb. | .38-.40 |
| Bees, yellow, crude, Brazil, 100 lbs. | lb. | .32½ |
| Carnauba, refined, bags | lb. | .68-.69 |
| Montan, bags | lb. | No prices |
| Spermaceti, blocks | lb. | .24-.25 |
| Whiting, precipitated, bags, l.c.l. | ton | $20.00 |
| Xylene (Xylol), ind., returnable drums, works | gal. | .31 |
| Zinc, carbonate, tech., bbls. | lb. | .14-.16 |
| Cyanide, 100 lb. kegs | lb. | .33 |
| Chloride, tech., granular, drums, c.l., wks. | lb. | .05 |
| Sulphate, crystals, bbls., l.c.l. | lb. | .039 |